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ABSTRACT

This issue of "ENC Focus" focuses on teaching in the standards-based classroom. Contents include: (1) "Creating Ideals and Making Them Real" (Annette Thorson); (2) "ENC Partners: Eisenhower National Clearinghouse Sites" (Juyong Pae); (3) "Innovators' Forum"; (4) "Using the Internet: Connecting Students through Collaborative Projects" (Kimberly S. Roempler); (5) "Students Write: Patterns Are" (Peggy Bush); (6) "The Heart of Systemic Reform" (Nancy Love); (7) "An Interview with Marilyn Burns: Meeting the Standards--Don't Try to Do It All By Yourself" (Terese Herrera); (8) "Inquiry in the Standards-Based Science Classroom: A New Resource for Teachers and Teacher Educators" (Tina Winters and Karen Hollweg); (9) "There Are Standards and Then There Are Standards" (Judy Spicer); (10) "Student Learning Groups That Really Work" (Carol Damian); (11) "Inside the Minds of Six Year Olds" (Edward Mooney, Cheryl A. Lubinski, and Paul Saaty); (12) "Concept Maps: Finding Our Way on the Road to a Standards-Based Classroom" (Judy Ridgway and Linda Saville-Rath); (13) "A Snapshot of Assessment in a Standards-Based Classroom" (Carol Midgett); (14) "Dovetailing Standards" (Louise Stivers); (15) "Technology Can Help You Meet the Standards" (Jaclyn Synder); (16) "High Standards for All--A Key Ingredient of Systemic Reform" (Aleta You); (17) "A Safe Environment for Creating a Standards-Based Classroom" (Sandra E. Fluck); (18) "Destination: Standards" (Keith C. Rittel); (19) "A Systematic Approach to Standards-Based Learning" (Carol Damian and Teresa Herrera); and (20) Featured Resources. (YDS)

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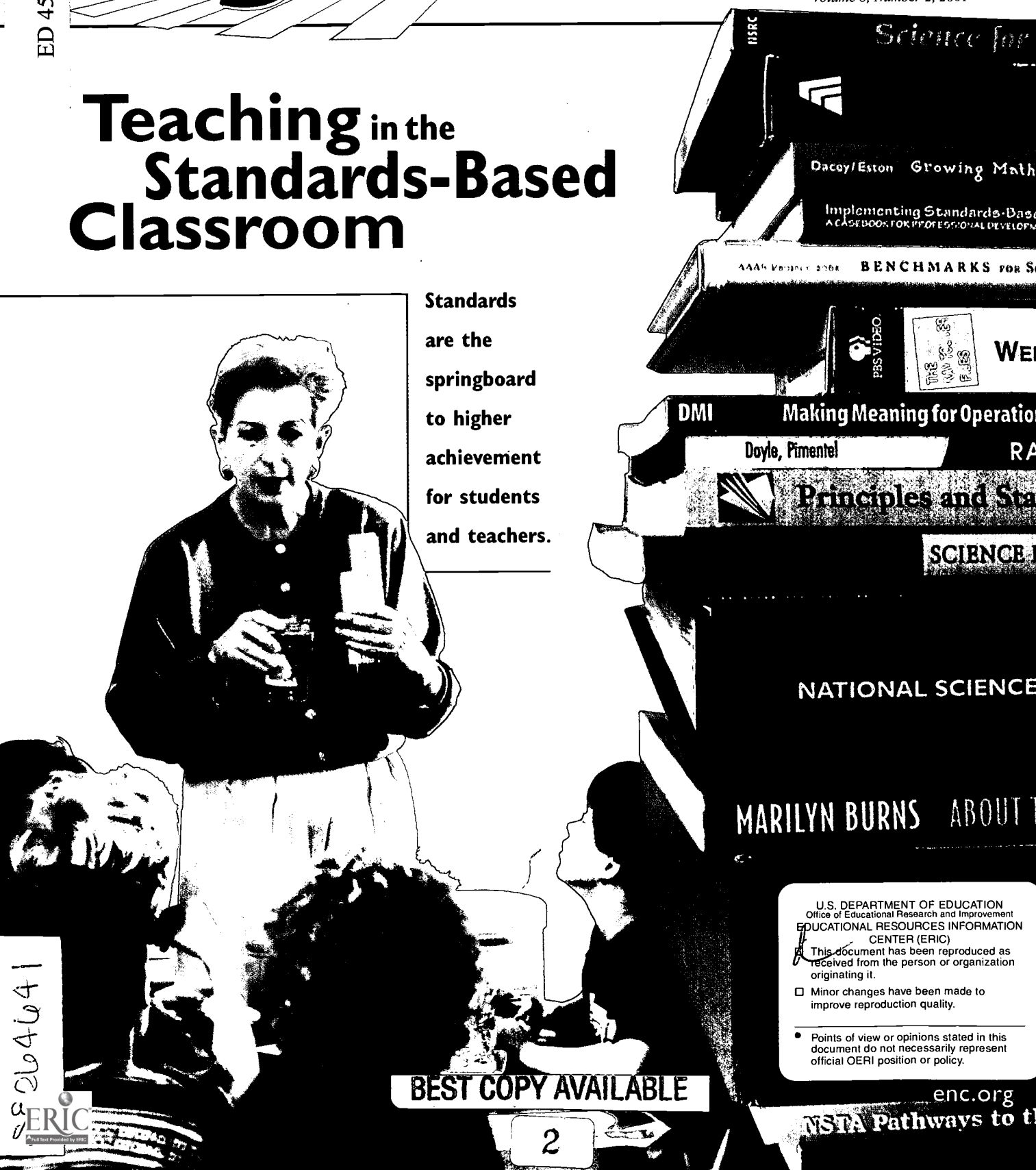
A Magazine for Classroom Innovators

Volume 8, Number 2, 2001

Teaching in the Standards-Based Classroom

Standards are the springboard to higher achievement for students and teachers.



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Roderick R. Paige, Secretary

Office of Reform Assistance and Dissemination
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The Mission of the Eisenhower National Clearinghouse

is to identify effective curriculum resources, create high-quality professional development materials, and disseminate useful information and products to improve K–12 mathematics and science teaching and learning.

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Contents

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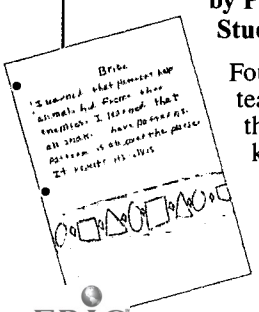
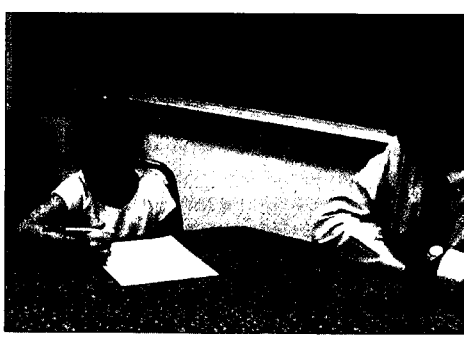
A Magazine for Classroom Innovators
Volume 8, Number 2, 2001

Theme for this Issue:
Teaching in the Standards-Based Classroom

Update: Around the Clearinghouse and the Nation



Focus on Teaching in the Standards-Based Classroom



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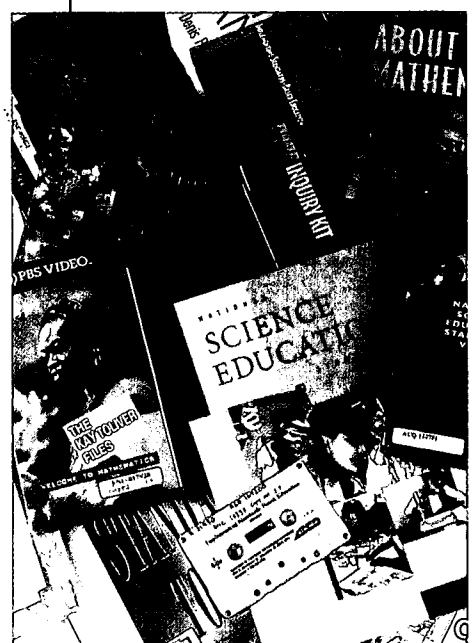
Focus on the Collection

This section presents descriptions of exemplary resources from the ENC Collection selected to illustrate this issue's theme.



Look for this icon throughout the magazine. It invites you to access the Internet for more information, more resources, more ideas for your own classroom innovations. The electronic version of this publication will help you get started. Visit enc.org/focus/standards

Update ...
Around the Clearinghouse and the Nation

This section features columns, essays, and news of interest to classroom innovators.

What is Eisenhower National Clearinghouse?

Funded through a contract with the Office of Educational Research and Improvement of the U.S. Department of Education, ENC was created in 1992 to collect and catalog curriculum resources for K-12 mathematics and science educators and to disseminate information about federally funded educational programs. Our products and services have evolved to include a web site, ENC Online (enc.org); *ENC Focus*, a free quarterly magazine; and numerous other publications and services. For more information on ENC's vast collection of curriculum resources, see page 50.

Editorial

Creating Ideals and Making Them Real

by Annette Thorson, ENC Publishing

Americans . . . expect strict standards to govern construction of buildings, bridges, highways, and tunnels; shoddy work would put lives at risk. They expect stringent standards to protect their drinking water, the food they eat, and the air they breathe. . . . Standards are created because they improve the activity of life.

—Diane Ravitch (1995)

Thinking in those terms, it only makes sense for Former Assistant Secretary of Education Ravitch to advocate standards to improve the effectiveness of American education. Many people agree. Research has shown that most Americans strongly support higher standards (Farkas, Friedman, Boese & Shaw, 1994), that teachers believe higher standards will improve their students' academic performance (Johnson & Farkas, 1996), and that students see value in higher standards and even say they will work harder and learn more as a result (Friedman & Duffet, 1997).

With that kind of agreement, it is not surprising that creation of educational standards has become a very active enterprise indeed. Mid-continent Research for Education and Learning (McREL) has compiled a history of the standards movement, which is available on that organization's web site (www.mcrel.org/standards-benchmarks). Beginning with *A Nation at Risk*, the 1983 report of the National Commission on Excellence in Education, which McREL views as "the initiating event of the modern standards movement," the history lists 62 milestone documents or events. You can be sure that number 62, the 2000 publication of *Principles and Standards for School Mathematics* by the National Council of Teachers of Mathematics, will not remain the endpoint of the list for long. It is also important to note that the list does not include the ongoing efforts to create standards documents on state and district levels.

Right in the middle of this creation of standards—the ideal—classroom teachers are being asked to take the next step, to make the ideal real. As articles in this issue of *ENC Focus* illustrate, teachers are commited to making that happen, but it is not always easy. One author notes that the standards are "daunting"; another admits "I was overwhelmed." Some authors can inject a light note "we ran into several potholes," while others talk about struggle and anxiety.

Ventilating these feelings is therapeutic, we believe, but that is not the purpose of this issue. Our goal is to suggest ways to use whatever standards are mandated in your school to really improve your practice—to help you teach in a standards-based classroom.

To that end, we talked to respected mathematics education expert Marilyn Burns. Her common-sense advice to all teachers begins on page 16. Other articles offer many different perspectives. Tina Winters and Karen Hollweg of the National Research Council describe a new resource to help science teachers bring the standards to their practice (page 20), and Aleta You, who works with New Jersey Statewide Systemic Initiative, discusses educational equity in light of the standards (page 43).

Teacher educators Cheryl Lubinski and Edward Mooney discuss how one preservice teacher came to understand the standards (page 30), and professional developer Sandra Fluck describes how she helped a district establish a safe environment for creating standards-based classrooms (page 46). School principal Keith Rittel tells how to use data to move schools in the right direction, one building at a time (page 48).

We know you value articles that come straight from the classroom. First-grade teacher Carol Midgett, who helped write the new NCTM standards, discusses assessment (page 37), while Judy Ridgway and Linda Saville-Rath describe the use of concept mapping with older students (page 34). Louise Stivers tells how a unit she used with her second graders met district standards in mathematics, science, and language arts (page 38), and Jaclyn Snyder describes how technology helps high school students learn algebra (page 40). Carol Damian provides specific ideas for the use of standards-mandated learning groups with all ages of students (page 25).

Judy Spicer (page 23) puts a different spin on the topic by providing a glimpse at the National Board for Professional Teaching Standards (NBPTS).

We realize that people may open a magazine with the word "standards" on the cover with the expectation that it contains articles on a closely related topic: state-mandated standardized testing. For that, I would like to refer you to an earlier issue of *ENC Focus* on the topic Assessment That Informs Practice. The full text of that issue and all issues of *Focus* is available on ENC's web site (enc.org/focus).

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Farkas, F., Friedman, W., Boese, J., & Shaw, G. (1994). *First Things First: What Americans Expect From Public Schools*. New York: Public Agenda.

Friedman, W. & Duffett, A. (1997). *Getting By: What American Teenagers Really think about their Schools*. New York: Public Agenda.

Johnson, J. & Farkas, S. (1996). *Given the Circumstances: Teachers Talk about Public Education Today*. New York: Public Agenda.

Ravitch, D. (1995). *National Standards in American Education: A Citizens Guide*. Washington, DC: Brookings, pp. 8-9.

Writers' Guidelines for ENC Focus

Guidelines for Content of Articles

ENC publishes print and electronic materials on specific topics of interest to teachers of K-12 mathematics and science. Articles submitted for consideration should be grounded in the national educational standards while being short (500 to 2,000 words) and compelling. It is essential that articles promote educational equity and advance the principle of "education for all."

We particularly invite teachers to write about their classroom experiences, using first person and a conversational tone. Please note that library research papers written in academic language for graduate school courses are unlikely to be selected for publication. We do, however, encourage you to include a few, carefully chosen references or a brief reading list. All content must be original, and all quotations must be properly cited.

We also publish essays by K-12 students about their successes in mathematics and science. Teachers are encouraged to assist students in writing and submitting materials for publication.

ENC is not interested in publishing articles that have the main goal of promoting commercial products.

Guidelines for Photographs and Illustrations

Photos or other illustrations add interest, and good illustrations increase your chances for publication. Photos should show students involved in an activity rather than looking directly at the camera. Students in laboratory settings must be shown following appropriate safety guidelines and wearing proper safety attire, including eye protection. Please select photos that depict diverse students and teachers working together.

Please note that we can use photos of children under 18 years of age only if we receive written permission signed by a parent or guardian. It is important that the form specify that permission is granted for use of the image on the Internet as well as in print. ENC will provide permission forms on request.

Photos, slides, negatives, drawings, or charts may be mailed to the editor. We prefer color, but black and white photos are also acceptable. Photos should be at least 4x6 inches. Tape an identifying label on the back of each item rather than writing on it. Photos and other illustrations or materials will be returned only on request. Keep in mind that we will not be able to return any material until after the magazine is printed.

If you use a digital camera, please take photos at your camera's highest setting, which may be 1024x768 or 1240x960. You can then attach those photos to an email or send them to us on a disk. Scanned images need to be at least 300 dpi; the dimension of the image should be at least 4x6 inches. Save the images as jpeg files. Digital photos printed on photographic paper with an ink jet printer are not acceptable because the resolution is inadequate for reproduction.

Submission Details

Authors of unsolicited manuscripts are urged to send a brief proposal via email well in advance of the deadline for the upcoming topic. Proposals should explain how the article fits the topic and how it serves the needs of K-12 teachers. Future topics and deadlines are regularly published in both the print and online versions of the magazine.

We prefer that manuscripts be submitted electronically. A Microsoft Word or text file attached to an email message works well. Manuscripts can also be submitted by fax or regular mail. Paper submissions must be typed in a large, clear font; this is especially important for those sent by fax.

Each manuscript must be accompanied by the full names, postal addresses, telephone numbers, and email addresses of all authors. In addition, each author must be further identified with one or two sentences providing the author's professional affiliation and background.

We cannot consider manuscripts that have been submitted elsewhere. Occasionally we reprint outstanding articles that have been previously published. Authors suggesting their own articles for reprint must provide written permission from the original publishers.

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The Editing Process

Your proposal or manuscript will be acknowledged as soon as possible after it is received. Inclusion of your email address greatly speeds this response.

Please keep in mind that just because an article has been acknowledged does not mean it has been accepted for publication. Sometimes we cannot determine whether a particular article will be published until all articles for the issue have been edited.

All articles, solicited and unsolicited, are reviewed by ENC's mathematics and science education experts both before and after they are edited, and edited articles are reviewed by officials at the U.S. Department of Education. At any step in this process, ENC reserves the right to decline to publish any article, to delay publication until a later issue, or to publish an article online and not in the print version of the magazine.

During the editing process, you may be contacted to answer questions about your article. Or you may just receive an edited version of your article for your approval. At this point we need an immediate response, even if the article is correct to print as edited.

Please keep in mind that articles may be changed significantly to suit the needs of our audience, to match our style, or to fit in the space available. We want the edited version to be factually correct and to express your views accurately, but ENC retains the right to make final editing decisions.

When Your Article Is Published

ENC mails five copies of the print version of the magazine to each author. Requests for bulk shipments of the print version will be filled while supplies last.

Upcoming topics and deadlines are listed on page 5.

For more information or to submit a manuscript, contact:

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Eisenhower National Clearinghouse Demonstration Sites

No matter where you live, there is an ENC Demo Site to serve you. Here are just a few examples of their work.

by Juyong Pae, ENC Publishing

To help disseminate information about efforts to improve mathematics and science education and about curriculum resources, ENC has established Demonstration Sites in the ten education regions of the country as well as at ENC in Columbus, Ohio, and at the Capital Collection at George Washington University in Washington, DC. The Demo Sites are located at educational organizations that include the Eisenhower Regional Consortia, museums of science and industry, universities, a PBS station, and a national research laboratory, all of which offer an array of impressive services for educational outreach. (See pages 8 and 9 for a complete list.)

Each ENC Demonstration Site provides access to ENC and to Eisenhower Regional Consortia web sites and other services. Print publications such as this magazine are also distributed through the Demo Sites. Hosting an ENC Demo Site is just one way that each of these organizations supports math and science education. Many offer opportunities for teachers to expand their knowledge of content, participate in research and internships, develop instructional materials, and experience hands-on practices that best promote effective classroom learning.

In Illinois

The Fermi National Accelerator Laboratory in Batavia, Illinois, home of the ENC Demo Site serving the North Central Region, offers summer workshops for teachers to train on Fermilab-developed curricular units in physics and prairie science. The units are designed to engage students in an experience that will broaden their understanding of how science is done. Teachers experience hands-on activities and learn how to incorporate the materials into their regular classroom curriculum.

One of the units, Beauty and Charm, is an introduction to particle physics for middle school students. ("Beauty" and "charm" are attributes of quarks.) The unit features simple hands-on experiments that demonstrate concepts such as How small is small? and How can we measure what we cannot see? It also looks at methods of science and the human element of science.

Another Fermi Laboratory education program is Fermilab Leadership Institute Integrating Internet, Instruction, and Curriculum (LiNC) Online, a program to help teachers design effective Internet projects based on principles of engaged learning—student-centered, collaborative, inquiry-oriented projects. A third education program, QuarkNet, engages high school teachers and students in current particle physics research.

The web site of the Fermilab Education Office (www-ed.fnal.gov/ed_home.html) offers complete information about the lab's many programs in support of math and science education.

In Pennsylvania

The Franklin Institute Science Museum (www.fi.edu) in Philadelphia, Pennsylvania, is the location of the ENC Demo Site for the Mid-Atlantic Region. Among the numerous programs is Wired@School, which showcases a collection of web sites developed by Franklin Institute Online Fellows, outstanding teacher-pioneers in using computer technology in K-8 schools. These Fellows have developed web sites that provide teachers instruction in use of technology in the classroom. The sites are centered on project and lesson plan ideas, and show teachers what they, too, can do.

Have You Seen the Wind? is a web site from the collection that helps teachers incorporate the Internet into lesson plans on wind and severe weather. It eases them into technology integration by providing a scale for teachers to use to rate themselves and to see what their next steps might be. The scale is an adapted Saffir-Simpson Scale (used for measuring hurricane severity) where teachers can work their way up to a Category 5—Internet Using Educator!

Wired@School is part of a larger program, the Science Learning Network (SLN) (www.sln.org), which develops classroom resources and provides teachers with support in doing science inquiry. SLN is a collaborative partnership of science museums, schools, teachers and students, and other institutions.

New Site

In the Northeast, the ENC Demonstration Site is now housed at the WGBY Center for Instructional Technologies (CIT) in Springfield, Massachusetts. Karen Sullivan is the director. WGBY is a PBS station in the area. Serving as a professional development resource center for Massachusetts educators, CIT offers comprehensive K-12 technology training in a 17-station, dual-platform computer lab. Also available are a software preview and evaluation library and a wide assortment of PBS videos and teaching resources. For more information visit the CIT web site (www.wgby.org/edu/cit).

Juyong Pae was formerly a member of the ENC Publishing staff. She currently is an editor for a textbook publisher.

The Eisenhower Network

ENC is part of the National Network of Eisenhower Regional Consortia and Clearinghouse, a nationwide collaboration that provides support to mathematics and science educators across the country. In addition to ENC, the Eisenhower Network includes ten Eisenhower Regional Consortia that work toward these goals:

- To identify and disseminate exemplary mathematics and science instructional materials;
- To provide technical assistance to educators in implementing teaching methods and assessment tools;
- To collaborate with local, state, regional, and national organizations engaged in educational improvement.

Also part of the Eisenhower Network are 12 ENC Demonstration Sites—one in each region, one at ENC in Columbus, Ohio, and one at The George Washington University in Washington DC. These sites provide users with the opportunity to access ENC services electronically and to pick up free publications.

In recent years, the Eisenhower Network has spread even further with the creation of ENC Access Centers. Located throughout the country, these volunteer centers are staffed to distribute ENC publications and to teach local educators about the Eisenhower Network. There are already 125 Access Centers, with more added each month.

Contact the Eisenhower Consortium or ENC Demonstration Site that serves your state for assistance in improving mathematics and science education.

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Alaska, Idaho, Montana, Oregon, Washington

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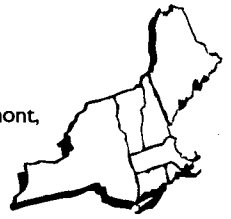

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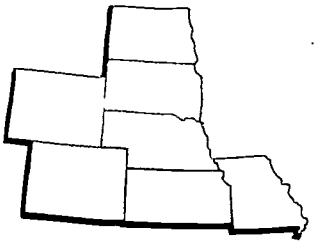

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Mid-Atlantic Region

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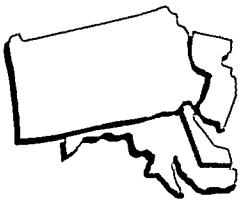

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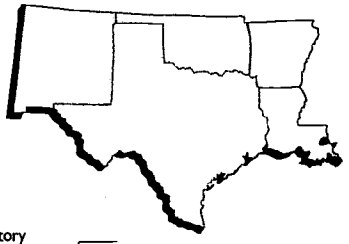
Southwest Region

Arkansas, Louisiana, New Mexico, Oklahoma, Texas



consortium

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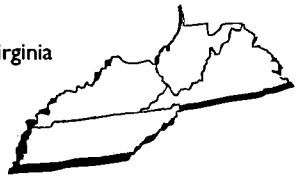
Appalachia Region

Kentucky, Tennessee, Virginia, West Virginia



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ENC Capital Collection & Demonstration Site

Washington, D.C.

demo site

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Innovators' Forum

After publication of the *ENC Focus* issue on the topic Making Schools Work for Every Child, (vol.7, no.4) we received reader reaction to some of the material. Here is one email message and a response from the American Association of University Women (AAUW) Foundation, an organization that contributed one of the articles about gender equity. See full text of the article and the entire issue of *Focus* on ENC's web site (enc.org/focus/equity).

Reader's Comment:

I am presently reading the ENC magazine, and there are plenty of articles about gender equity. I would like to know why there are never any articles about why special education is almost 67 percent male and why no one thinks males are discriminated against when girls score higher in the verbal section on the SAT as they have been over the years.

I believe that boys are also shortchanged, but it is politically incorrect to say so.

Thank you,
Leonard Paranac, Principal
Central Elementary School
Franklin, Pennsylvania

Author's Response:

The *ENC Focus* story highlighting innovative programs by American Association of University Women (AAUW) Educational Foundation's Eleanor Roosevelt Teacher Fellows reflects the Foundation's commitment to encouraging girls' achievement in math, science and technology—fields traditionally underrepresented by women. If girls drop out of these areas early, opportunities to pursue careers in these important 21st century fields typically are lost.

While girls' participation in mathematics and science has increased over the past decade, there has not been a comparable rise in their involvement in high-tech activities—computer science classes, computer laboratories, and clubs. At the same time, it is evident that boys also face significant hurdles in achieving success.

Since 1992 the AAUW Educational Foundation has researched what's best for girls in schools, while also looking at the broader picture of what works best in schools for both girls and boys. Our major research reports—from *The AAUW Report: How Schools Shortchange Girls* (1992) to our recent *Tech-Savvy: Educating Girls in the New Computer Age* (2000)—all recognize that schools need to address problems faced by both boys and girls.

What's also clear is that educating our children is not a zero-sum game, in which a gain for girls must be at the expense of boys. To find out more about how the needs of girls and boys are compatible and address common concerns, the AAUW Educational Foundation recently convened a two-day symposium of prominent scholars of girls' and boys' educational experiences. Their discussions will be published in a report called *Beyond the Gender Wars*.

AAUW Educational Foundation's mission is to advance education and equity for women and girls, supported through our fellowship, grant, and research programs. At the same time we recognize that truly equitable and effective schools, by definition, must work for both girls and boys.

Sharon Schuster
President, AAUW Educational Foundation

Using the Internet

Connecting Students Through Collaborative Projects

Sharing data is just one way that students can collaborate with others over the Internet.

by Kimberly S. Roempler
ENC Instructional Resources

The big change that's coming is not technology—it's relationships. Connecting people together is the big change.
—Alan November

I came across this quote by Alan November as I was reading an article on his web site (www.anovember.com/articles/asilomar.html). That is when it really hit me—the Internet is causing fundamental changes in the ways students learn and teachers teach, as well as in the interaction between student and teacher. Online collaborative projects are among the best

Roempler's Recommended Resources

The Monarch Watch (www.monarchwatch.org)

The goals of this collaborative project are to promote the conservation of Monarch butterflies and to involve thousands of students and adults in a cooperative study of the Monarchs' spectacular fall migration. Monarch butterflies are tagged and monitored as they travel more than 3,000 miles. (Grades K-8)

The GLOBE Program (www.globe.gov)

Daily observations of local weather can unveil important information about longer-term climate patterns. The GLOBE (Global Learning and Observations to Benefit the Environment) Program brings together students, teachers, and scientists from around the world who work together to learn more about the environment. By participating in GLOBE, teachers guide their students through daily, weekly, and seasonal environmental observations, such as air temperature and precipitation. Using the Internet, students send their data to the GLOBE Student Data Archive. Scientists and other students use these data for their research. This is an excellent opportunity for teachers to integrate computers and the World Wide Web into classroom activities and to get students involved in hands-on science. For a story about a fourth-grade class that participated in the GLOBE program, visit the online version of a previous issue of *ENC Focus* (enc.org/focus/realworld). (Grades K-12)

illustrations of the educational impact of the World Wide Web.

The collaborative projects I'm talking about allow students to interact directly with other students as well as with scientists and other experts around the world. When this happens, students are in charge of their own learning—they generate their own line of inquiry rather than simply providing answers to teachers' questions. With a bit of guidance, students can learn to develop their own inquiry-based questions. It is a balancing act: teachers need to give students considerable responsibility but still must actively shape the nature of their questions and of their analyses and interpretations of the answers.

Collaborative projects are designed to integrate Internet technology into the curricula and to foster communication and cooperation. These kinds of projects can be highly motivating to students because they bring classrooms together from across the country and globe in shared learning experiences. Students are required to go beyond their own experience, to share with others, and to consider alternative points of view. Not only do students share data, they share perspectives and cultures. What could be more exciting?

Some wonderful collaborative projects have been available online for years. However, perhaps the best way to get started is to participate in a simple email exchange activity. This is the most common way to share data.

A good place to begin is the Lightspan.com Global School Network (GSN) web site. (Go to www.lightspan.com/ and click on Teachers, then Projects Registry.) You will find a registry of many projects from many sources. You can also design, post, and moderate a project that your class and others can join. A template is included to help you begin planning a project. You can also subscribe to the GSN listserv to get email updates on new projects listed at the site.

If your class is ready for more complex collaborations, visit some of the web-based projects on the Recommended Resources list that accompanies this article.

Keep in mind that even if a project has already been completed for the year and it is too late for your class to join, you can use the basic concept and modify it to meet your needs or plan on joining the project next year. Many times data from previous years have been archived so that your class still can work with real data collected from all over the world.

Sometimes projects have lost their funding but data collected over the years are still available on the web site. An example is the EnviroNet Monitoring Projects web site (earth.simmons.edu/monitoring_projects/index.html). The site provides data and protocols for projects such as Acid Rain, Bat Zone, and Salt Track even though no new data are being collected.

You can find more collaborative projects by going to ENC Online (enc.org), clicking on Web Links, and then Collaborative Projects.

Kimberly S. Roempler is ENC's Associate Director for Instructional Resources. She is a veteran physical sciences teacher and teacher educator.
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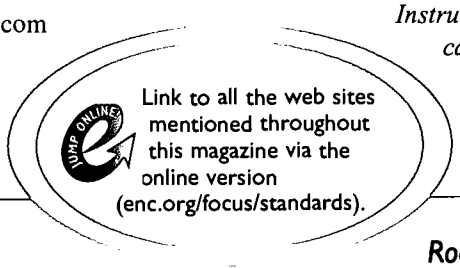


Center for Improved Engineering and Science Education (k12science.org/currichome.html)

The Center for Improved Engineering and Science Education (CIESE) has developed collaborative projects on a variety of topics. Projects include Human Genetics: A Worldwide Search for the Dominant Trait; The Global Water Sampling Project; Boil, Boil, Toil, and Trouble: The International Boiling Point Project; and many others. (Grades 3-12)

Estuary-Net Project (inlet.geol.sc.edu/estnet.html)

Water quality monitoring activities are conducted in the Estuary-Net Project, which was developed by the National Estuarine Research Reserve System in response to water quality problems in coastal areas. This project strives to develop collaborations among high schools, volunteer groups that monitor water quality, local officials, state Coastal Zone Management programs, and National Estuarine Research Reserves to solve non-point source pollution problems in estuaries and their watersheds. Water quality data collected by Estuary-Net participants are sent to a homepage on the Internet. Students are encouraged to explore data collected in other watersheds in their state and throughout the country. (Grades 9-12)

RoadKill Monitoring Project (www.edutel.org/roadkill)

In this project, students monitor animals that have been killed by motor vehicles along the road. Special attention is paid to environmental conditions that may have contributed to an animal's death. Students monitor roads that they travel to and from school. Data on flattened "roadents" are entered into a chart along with the road conditions and environmental parameters. The purpose of this project is to give students an understanding of the natural world around them. Roadways have divided natural corridors for many species of wildlife, and roadkill statistics are evidence of this phenomenon. (Grades 5-12)

Journey North (www.learner.org/jnorth/)

The journeys of a dozen migratory species are tracked each spring through this collaborative project. Students share their own field observations with classrooms across the hemisphere. In addition, students are linked with scientists who provide their expertise directly to the classroom. Several migrations are tracked by satellite telemetry, providing live coverage of individual animals as they migrate. (Grades 4-12)

NickNacks Telecollaborate! (home.talkcity.com/academydr/nicknacks/)

This site provides guidelines for collaborating in the global classroom whether you are participating with an existing collaborative project or developing one of your own. (Grades K-12)

Patterns are . . .

In their writings, fourth graders tell their teacher and themselves what they know and how they respond to new math concepts.

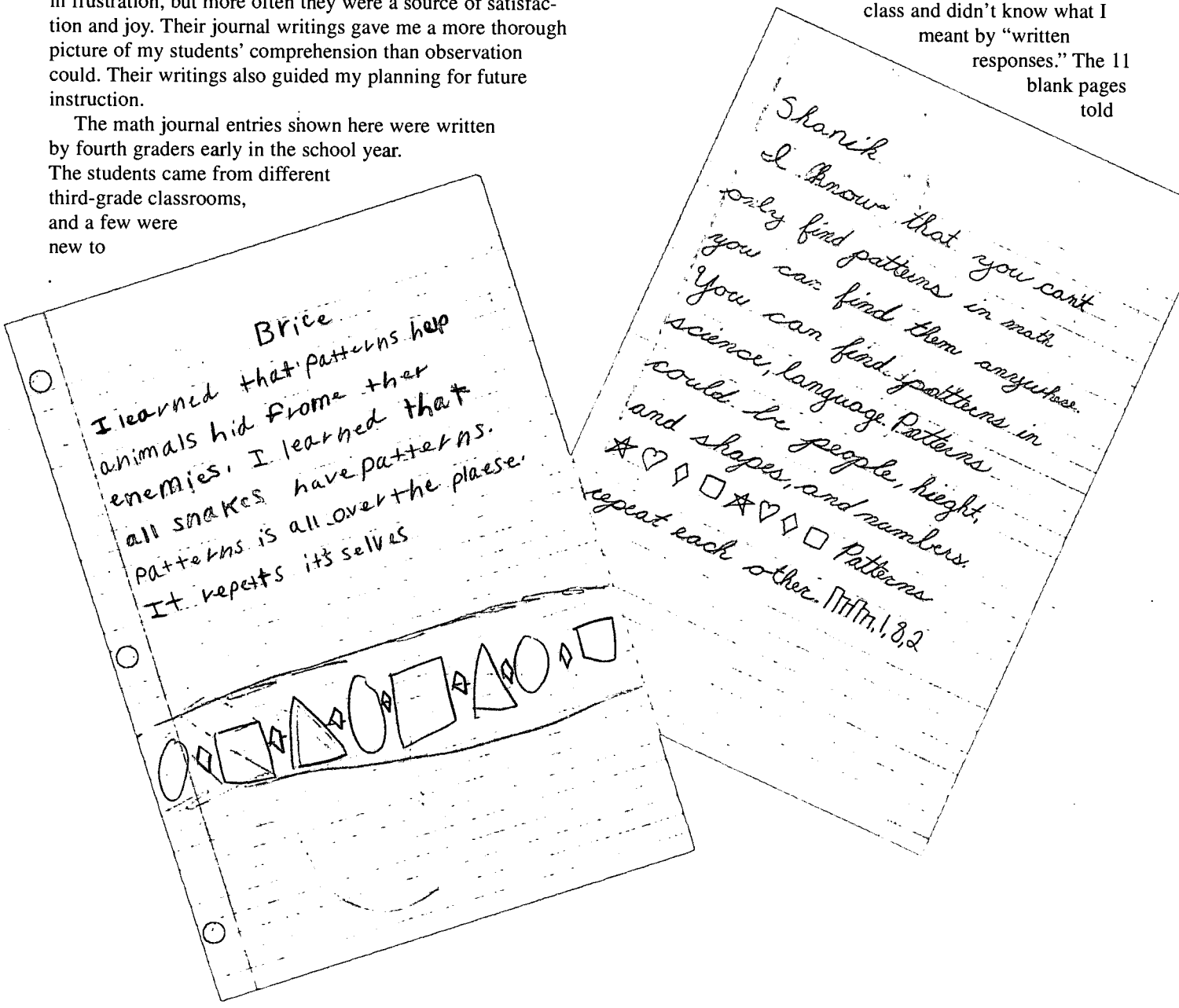
by Peggy Bush, Beechwood School, Whitehall, Ohio

A few years ago I began asking students to comment in writing on a fact or concept that had been introduced in class. Generally, I posed a question to which they could respond. Sometimes the responses made me feel like crying in frustration, but more often they were a source of satisfaction and joy. Their journal writings gave me a more thorough picture of my students' comprehension than observation could. Their writings also guided my planning for future instruction.

The math journal entries shown here were written by fourth graders early in the school year. The students came from different third-grade classrooms, and a few were new to the building. As a review, and to find out how well the children understood the patterns concept, I had presented one or two activities. From their writings, I would decide whether to spend more time on simple patterning or move on to more complex patterns. I posed this question: "Tell me what you have learned or already know about patterns. Why are they important?" The children had about 30 minutes to respond.

Twelve students responded, and I found their responses encouraging. Most of the 12 understood patterns as repeating units and knew that patterns are found in places other than the math classroom. Some could also draw or write an example of a pattern. I wanted to talk with a few of the students to clarify their responses.

Eleven students gave no response. Some complained that they did not know what to write; others said they had never written journals in math class and didn't know what I meant by "written responses." The 11 blank pages told

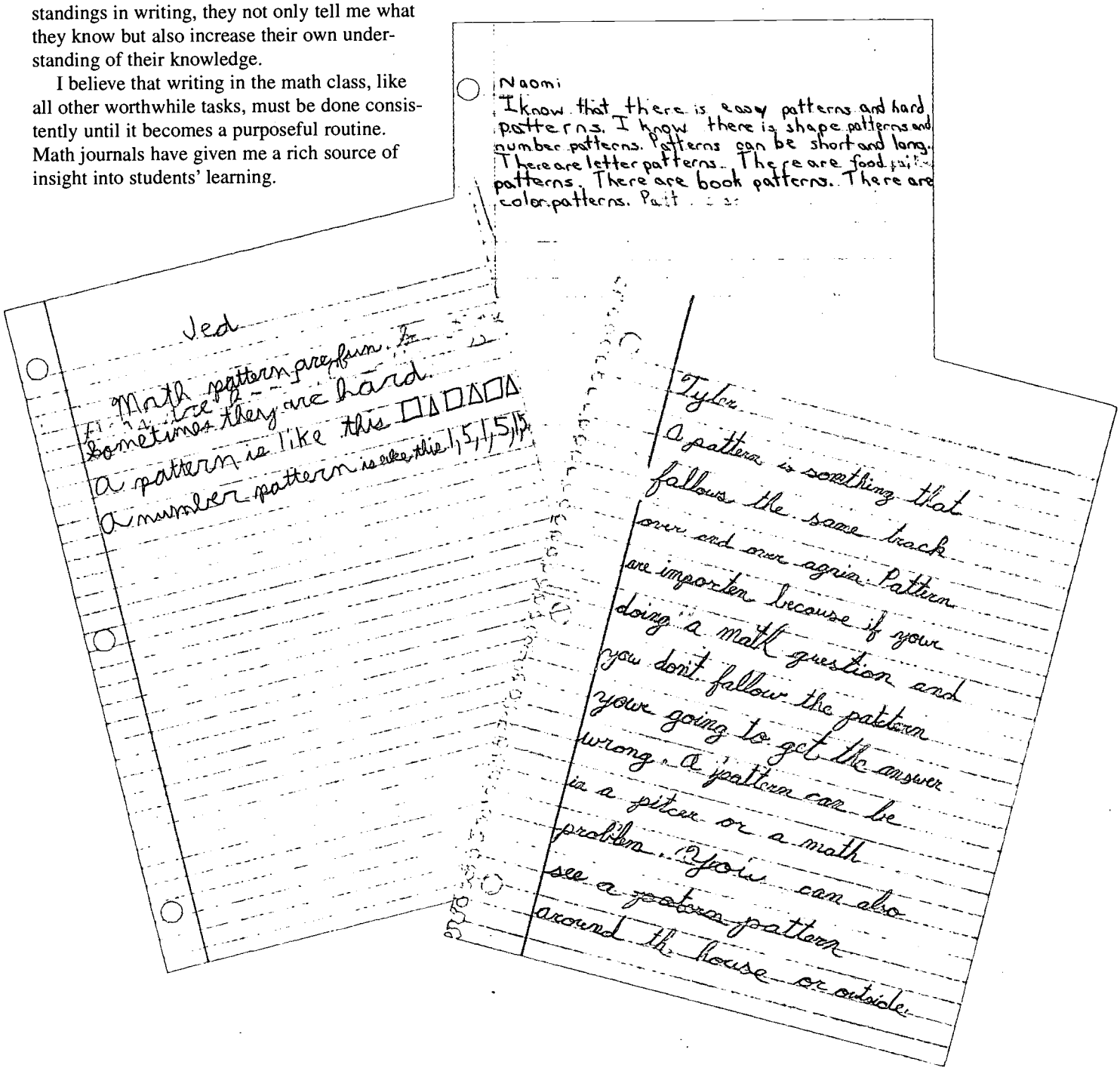


me that even students who understood the concept of patterns might find writing in math class not only novel but confusing and frightening as well. For these students, I found other ways of evaluating their understanding while encouraging them to write down their thoughts in a future journal assignment.

It is possible that I could have discovered what most students understood about patterns by giving them a worksheet assessment. However, when the students share their understandings in writing, they not only tell me what they know but also increase their own understanding of their knowledge.

I believe that writing in the math class, like all other worthwhile tasks, must be done consistently until it becomes a purposeful routine. Math journals have given me a rich source of insight into students' learning.

Peggy Bush is a fourth-grade teacher and math coach at Beechwood School in Whitehall, Ohio. For the past seven years, she has also been active in the Science and Mathematics Network's Teacher/Leader Program. The Network, a part of the Ohio Regional Professional Development Centers, trains K-8 classroom teachers to be Math Leaders for their districts.



Focus on Teaching in the Standards-Based Classroom

This section presents articles on the theme of this issue

Themes for *ENC Focus*

Each issue of *ENC Focus* presents articles on a topic of concern to classroom innovators. Previous issues have covered topics such as Making Schools Work for Every Child, Mathematics & Science in the Real World, Assessment That Informs Practice, Integrating Technology in the Classroom, and Inquiry & Problem Solving. The online version of *ENC Focus* (enc.org/focus) provides the full text of all issues.

The best source of new ideas and helpful tips for improving science and mathematics education is the classroom teacher. We invite you to join the community of *ENC Focus* writers. Check page 5 for upcoming themes. Our guidelines for writers appears on page 6 and online (enc.org/focus/write).

The Heart

A multifaceted vision for classrooms that promote student learning permeates the standards.

by Nancy Love, The Regional Alliance, TERC, Cambridge, Massachusetts

Virtually every national standards document, every state framework, and every local set of standards calls for fundamental changes in what teachers teach (curriculum), how they teach (instruction), and how student learning is assessed (assessment). Everyone seems to agree on one thing: if change does not reach the classroom level, all the talk of reform is for naught.

The challenge, of course, is to effectively implement the vision for mathematics and science classrooms called for in the standards.

This vision:

- emphasizes high expectations for all students;
- focuses on in-depth learning of a limited number of powerful concepts, emphasizing understanding, reasoning, and problem solving rather than memorization of facts, terminology, and algorithms;
- integrates scientific and mathematic inquiry with knowledge of science and mathematics concepts and principles;
- engages students in meaningful activities that enable them to construct and apply their knowledge of key science and mathematics concepts;
- reflects sound principles from research on how students learn;
- uses cooperative learning and techniques for asking questions that promote interaction and deeper understanding;
- features appropriate, ongoing use of calculators, computers, and other technologies;
- empowers students by enabling them to do science and mathematics, and increases their confidence in their ability to do so;
- develops in students the scientific and mathematical literacy necessary to make informed decisions and to function as full participants in society;
- assesses learning as an integral part of instruction;
- ensures that teachers have a deep understanding of their subject matter;

# of Systemic Reform

- provides ongoing support for classroom teachers, including continuing opportunities for teachers to work together to plan curriculum and instruction (Weiss, 1997; adapted by permission of Iris Weiss).

Note that the standards talk about curriculum, instruction, and assessment together, as a single vehicle. This reflects a new understanding of the three as an integrated system, not as independent activities. What unites them is a common focus on student learning. Standards shape what is being taught and how. Assessment provides evidence for attainment of standards.

What's nice about the unity of the three is that you can enter any door to start the change process. If you keep the focus on learning, any change in one area will inevitably lead to change in another. For example, if you decide to move first to performance-based assessments, curriculum and instruction will have to change if students are going to perform well on the new assessments. On the other hand, if you implement a new inquiry-based science curriculum, traditional short-answer and multiple-choice testing will soon be rendered inadequate to assess students' inquiry skills. The key is to start somewhere!

Photo by Louise Stivers

Nancy Love is the professional development specialist at the Eisenhower Regional Alliance for Mathematics and Science Education Reform.

This essay is reprinted from Love, Nancy (2000). Using Data—Getting Results: Collaborative Inquiry for School-Based Mathematics and Science Reform. *Cambridge, MA: The Regional Alliance for Mathematics and Science Education Reform at TERC: 4.9-4.11. Used with permission from Nancy Love and Iris Weiss.*

Reference

Weiss, Iris R. (1997). The Status of Science and Mathematics Teaching in the United States: Comparing Teacher Views and Classroom Practice to National Standards. *NISE Brief* (University of Wisconsin, Madison) 1(3): 1-7.

An Interview with Marilyn Burns

Meeting the Standards—Don't Try to Do It All By Yourself

An internationally renowned educator describes ways to make educational standards come to life in your classroom.

by Terese Herrera, ENC Instructional Resources

A mathematics teacher and a teacher educator, Marilyn Burns is uniquely able to connect the philosophy of the Standards of the National Council of Teachers of Mathematics (NCTM) to classroom teaching and to students' experiences in learning mathematics. She has spent years communicating her love of math and her love of teaching through workshops, presentations, articles, books, and videotapes, for students as well as teachers and parents.

You may know Marilyn Burns best as the author of *The I Hate Mathematics! Book* and *The Greedy Triangle*, or you may be most familiar with her books for teachers, such as *About Teaching Mathematics: A K-8 Resource*, *Writing in Math Class*, and the Math by All Means series. Her most recent book, *So You Have to Teach Math?*, offers sound advice for both new and experienced K-6 teachers.

ENC is grateful that she agreed to be interviewed on the topic Teaching in the Standards-Based Classroom for this issue of *ENC Focus*. Please note that at the beginning of our conversation, we agreed that, in general, the standards we were discussing were *Principles and Standards for School Mathematics* (NCTM, 2000), and that "*Standards*-based" refers to the vision of teaching and learning in that document.

What would a Standards-*based classroom be like?*

The essence of a *Standards*-based classroom is this: Everything you do with children needs to help them make sense of the mathematics they are learning.

A lot of mathematics that I learned in school, such as dividing fractions and using the square root algorithm, was very mysterious. I finally made sense out of it by pursuing mathematics in later studies, but I don't think that the instruction that I received as a child was always with the intent that I was supposed to do only what made sense to me and persist until I understood.

I think the bottom line is: Does a child need to think and reason in order to be successful? Or can a child be successful by repeating something that he or she learned by rote? If the first is true, to me, the classroom is moving toward the *Standards*-based. But if children can be successful without necessarily understanding, then I think that it is violating the very essence of the *Standards*.

The goal is to get kids to think, reason, and be able to apply their understanding to solve problems. Being able to solve problems is obviously the test of whether or not you understand something. The content of mathematics is important, but it needs to be taught from this basic premise.

What are your ideas on how to make a classroom, at whatever grade level, a place where students use sense-making as their basic learning strategy?

First of all, in planning instruction a teacher needs to look at the content and say, "What is it that I want my children to understand?" and secondly, "What is it that I want them to be able to do with that understanding?" It is really a question of both concepts and skills.

Teachers first need to have a sense of what the content is, and that's outlined in the five content standards. Then the next thing, the question that I always ask myself, is: "What experiences can I provide the children that would give them a way to start to make sense of this for themselves?" This is where I look at the process standards because they really address what children need to do to learn math—

- Problem solving—What kinds of problems can I present to children that would give them a chance to grapple with important ideas and skills?
- Reasoning and proof—What kinds of situations can I pose to children so that their reasoning is engaged and they have experience giving convincing arguments?
- Communication—How do I involve children in talking and writing to help them communicate what they are studying and learning, and hear the ideas of others?
- Connections—How do I help children see the connections among mathematical ideas rather than seeing concepts as isolated and separate from one another?
- Representation—How do I help children use the symbolism of mathematics to describe their thinking?

When I am planning new experiences for children, I use those five process standards as my guidelines. I say, "Am I providing kids the opportunity to problem solve, reason/give proof, communicate, connect, and represent?"

But there is another thing I think about, and this has been the biggest change for me in the last five to ten years. Teachers often say to me, "Children are supposed to understand, but is it okay to tell them something? How do I teach it?" One criticism that I frequently hear is that in reform math teaching there is no direct instruction.

But, of course, there is direct instruction. I make the dis-

tinction this way: I ask myself when teaching something new, "Where is the source of the knowledge for the child—inside or outside?" Mathematical concepts and skills rely on logical structures and learning them calls for making sense of these structures, so the source of learning is internal. But social conventions are also part of learning math, and the source for learning the conventions is external and can be another person, a book, television, or some other source outside the child.

Let's say, for example, that I'm teaching the signs for "greater than" and "less than." You can't figure out the sign—it's just a funny-shaped arrow. So it's appropriate for the teacher to teach this by telling.

But if I want to teach a child how to figure out if five-eighths is more than or less than or equal to a half, the child needs to make sense of these fractions, not merely memorize them or learn a rule, like "cross multiplying," that they might not understand. The source of that

Photo: Bob Adler Photography

understanding is inside the child's head.

To me that is the critical difference about a *Standards*-based curriculum—it makes the distinction between when you teach by telling and when you teach by giving children experiences to grapple with. The issue is—where is the source of the understanding for the child?

Some teachers tell us they feel overwhelmed by high-stakes testing. What are your thoughts on that issue?

I am not against tests. How else do we know how well we are doing? There has to be some accountability. Accountability that has some standardization makes sense because how else do I know that I am implementing the program that I am supposed to be implementing?

But when I see standardized, norm-referenced tests used for this purpose rather than standards-based, criterion-referenced tests, it makes my heart sink. In a norm-referenced test, you know that half of the children are going to be below the fiftieth percentile. It's like being graded on a curve in college, and I always thought that was grossly unfair. It just seems crazy to me that somebody is going to have to fail and someone is going to do well, and all students have to spread out in a particular distribution.

For example, as a standard, I would like to have every fifth-grader know the multiplication tables and be able to find the answer to multi-digit multiplication problems with accuracy and efficiency. It's possible that, on a criterion-referenced test, anywhere from 0 to 100 percent of the fifth-graders in our country would reach that standard. In this example, the standard is clear and there is the possibility for everyone to do well.

As teachers, we're not learning from most of these standardized tests, either about our teaching or about how to help our individual students. The tests too often give more pressure than help. I'd like to look at tests in a positive way, as a vehicle for me to improve my teaching and learn how to help children learn. I'd like a test that asks children to apply the understandings and skills that they are learning to problem situations.

At times I think about Mozart and Einstein. How would one test reveal the brilliance each possessed?

My biggest testing dream is to have ten problems on a test and say to a child, "Pick any seven and show your stuff!" Of course, that is pie in the sky, but short of that, I am not even against multiple-choice tests as long as students have to read and reason rather than perform things they learned by rote. If they have to read and reason on the test, then teaching to a test means everything that I do in class has to do with reading and reasoning, which are life skills in every subject area. In that situation, preparing for the test would go on all year rather than occur in a month of drilling the kids.

In some middle schools that I visit, students almost seem to resist learning, or to be focused on whatever can distract them and get them off task. It becomes very hard for teachers in those schools to do what I'd call "really teach." What would you say to them?

One realization that I've come to from visiting and teaching in many schools is the importance of the school leadership in setting the tone of learning in that school. The school principal is the key. In a school that functions well, the principal is a strong person who supports learning and insists that all the children are there to learn.

I can tell in a minute when I go into a school if the principal is one who pays attention to instruction or one who is so overwhelmed with the details of administration that he or she can't focus on the learning going on. Without the principal's support, nothing is going to happen in a school. An individual teacher may be innovative, but a school community is necessary to improve learning. As math educators, we haven't helped our principals understand what the goals are mathematically.

Middle school, in particular, can be toxic. I think it's a tough time of life for students. There's the socialization issue, which affects how they view mathematics. If math were seen as something "cool" rather than something for eggheads, kids would want to be part of it, but it's a really tough sell.

Also, at the middle school level you have departmentalization, so the question is how do you keep the staff from going off into their corners, and instead, encourage them to say, "How do we work as a community to support these children?" What do you tell a teacher who is struggling in this culture to do his or her best? You say, "Find your own professional community of support. Don't do it alone; you can't. None of us can do it alone."

What would you say to people who work in professional development, who present workshops or are teacher educators, about helping teachers be better math teachers?

I think we can't emphasize too much that you cannot teach what you don't know. Therefore, mathematics has to be at the basis of all that you do and the vehicle through which staff developers talk about pedagogical issues. I think the five process standards are important, but I worry that we spend too much time talking about the processes unrelated to the mathematics.

When you are working with preservice teachers, it is sort of hard because they have no classroom experience to ground their learning. The best you can do is strengthen their understanding of the mathematics that they have to teach and do so in a way that changes their notion of what the classroom might look like. Because we know people teach as they were taught, you have to teach preservice teachers in a way that you want them to teach and you have to help strengthen their mathematical understanding.

In working with inservice teachers, everything should be tied to what the teachers can actually try and implement in their classes. They really should have a chance to experience what they are learning with their own students.

Do you have suggestions for ways to improve the content knowledge of teachers?

I have this dream that will probably never happen: Oprah, Jay Leno, and Dave Letterman would do math problems on their shows and talk with their audiences about mathematics in ways that can promote interest and understanding. A cultural shift of that proportion is needed. Math should no longer be seen as something for the "haves" but not the "have-nots," interesting to eggheads but not accessible to others.

Another avenue for addressing content knowledge is through teachers' own textbook materials. When confronting a topic that they are not comfortable with in their teaching, they can learn from those materials. In some of the reform curricula, teachers will find mathematics explained in a way that can help strengthen their own understanding.

And I would love to see more kinds of learning available to teachers about mathematics, in ways that weren't frightening. I know teachers who are terrified to go back to their local college. What courses would they take there? The mathematics courses that are offered in colleges and universities typically have little to do with what elementary teachers have to teach. I'd love to see, for example, math courses available to teachers that would really help them understand the arithmetic that they have to teach.

Here is a question from arithmetic that I had never thought about before Suzanne Chapin and Art Johnson raised it in their book, *Math Matters*. When you look at a fraction, can you predict whether its decimal form will repeat or terminate? Also, some fractions just repeat, like .333...; others repeat in a form like .16666.... How do you know? How many numbers will be in the part that doesn't repeat? What about the numerator and denominator of fractions can give you information? In the eight years I taught eighth grade, it never occurred to me to think about that, and therefore it never occurred to me to talk with my students about these ideas. It was a lost opportunity.

Also, in none of my university math courses did those questions get raised, probably because they were considered too "elementary." We just assume teachers understand these elementary topics. And teachers of young children feel, "Well, I only have to teach sums to 20," but the essence of what they are teaching children to do in terms of taking numbers apart and putting them together is more than learning the sums to 20.

So in my dreams, we would have math on Oprah and Leno and Letterman, and the public would stop making math the butt of bad jokes. We would have good enough curriculum materials to help teachers learn math. We would have access to courses, in colleges and universities or online, where teachers could study in depth the math they have to teach. It is hard to imagine a course in arithmetic as a graduate course, and yet I think it is worthy. The course would be taught in the spirit of the *Standards*, where problem solving, reasoning, proof, communications, connections, and representations are the essence of the course even at the college/university level.

Please share any other thoughts about this topic—the Standards-*based math classroom.*

The *Standards* document is large and daunting, but I encourage teachers, when they are preparing to teach something, to take a look at what the *Standards* offer. The more that you think about a topic you will teach, the better prepared you'll be.

And, as I said before, you can't make changes by yourself. When I go into somebody's classroom, it's wonderful for the two of us to talk about the children and the lesson. We are too often isolated as teachers. Whatever teachers can do to break down that isolation—studying with another teacher, or talking with the principal about visiting other classrooms, or finding time to plan lessons together—can help. Don't try to do it all by yourself. Nobody learns in a vacuum, so why do we think that we teachers should?

Terese Herrera is ENC's mathematics resource specialist. Her career includes 15 years of teaching at the middle school and high school levels. Contact her via email (therrera@enc.org).

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U.S. to Host Olympiad

The United States will host the International Mathematical Olympiad in Washington, DC July 1 - 14, 2001, marking the first time the event is held in the U.S. since 1981. This prestigious event gathers 500 of the most talented high school-age mathematicians from more than 80 countries. Opening ceremonies for the Olympiad will be held at the Washington Mall on July 4, 2001.

You and your students can find useful materials and links to some of the most fascinating math sites on the Internet at the IMO 2001 website (imo2001.usa.unl.edu).

Inquiry in the Standards-Based Science Classroom:

A New Resource for Teachers and Teacher Educators

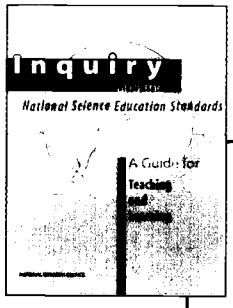
A new guide helps teachers provide standards-based science to students of all ages. The full text is available free online.

by Tina Winters and Karen Hollweg, National Research Council

A prominent feature of the *National Science Education Standards* (1996) is a focus on inquiry. The *Standards* call for students to engage in inquiry "to develop:

- understanding of scientific concepts,
- appreciation of 'how we know' what we know in science,
- understanding of the nature of science,
- skills necessary to become independent inquirers about the natural world, and
- dispositions to use the skills, abilities, and attitudes associated with science." (p.105)

A new addendum to the *Standards*, titled *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*, has been created to aid teachers and teacher educators in gaining a deeper understanding of the meaning of inquiry and provide substantive examples showing what it looks like in practice. The following description of a full-scale classroom inquiry was excerpted from one of the vignettes included in the *Guide*. As one reads and reflects on the vignette, it becomes obvious that inquiry is far more than a process.



An Inquiry Learning Experience

Students in Ms. Idoni's high school biology class walked around the lake in the city park, recording observations and questions in their journals. The field trip marked the beginning of an investigation to be conducted over the next several months. As she had every year for the past several years, Ms. Idoni would lead her class in a full and open inquiry.

The next day, the students discussed their observations and questions in class. They asked questions such as: Is the lake water safe to drink? Can people swim in the lake? What kinds of plants and animals live in the lake? How have humans changed the lake? Over the course of the discussion, it became clear that the students were most interested in change and stability in the lake and, in particular, the influence humans have had on this environment.

Ms. Idoni asked the students what important aspect of the lake they wanted to investigate. "Pollution" was the term Ms. Idoni heard first and most consistently. To clarify the students' understanding of pollution and the possible sources of human pollution in the city park lake, she asked the students to discuss in small groups what they meant by pollution. Over several class periods, they struggled with the issues of normal change, what counts as pollution, and possible human influences. As they grappled with these issues, the students seemed to center on one major idea: as living and non-living elements of an ecosystem interact, they change. Any study of changes in the environment, such as the city park lake, must begin with an analysis of the patterns of change under normal circumstances. The students realized they had to understand the natural functions of the interactive system before tackling the more complex question of the impact of human actions.

After hearing the results of small group discussions, Ms. Idoni facilitated a large group review of the ideas that had been generated and helped students identify an overarching question for the class to pursue in the investigation. The class decided on two general questions: Is city park lake polluted? If so, how have humans influenced the pollution?

Ms. Idoni provided guidance and prompting along the way but left it up to the class to determine how to carry out the investigation. The students decided to approach the inquiry by first establishing a baseline of

Assessing Classroom Inquiry

Categories that Ms. Idoni emphasized with students and used in her assessments (adapted from Science as Inquiry Standard, grades 9-12, abilities necessary to do scientific inquiry):

- Questions and scientific ideas that guide the investigation
- Design of the investigation
- Technology and mathematics for the investigation
- Use of evidence to present explanations
- Alternative explanations
- Conclusions and defense of explanations

data about city park lake. They organized their work to focus on three kinds of factors: physical, chemical, and biological. They divided into three groups, with each focusing on one of the factors. The group investigating physical factors was interested in temperature, color, limits of light penetration, and amounts and types of suspended particles. The chemical factors group wanted to learn about pH levels and the amounts of oxygen, carbon dioxide, phosphates, and nitrates present in the water. The biological group wanted to investigate the numbers and kinds of organisms. Group members collected data for two months, reporting all results to the other groups. Each group also reported about their ideas and what their library and computer searches suggested about the potential influence of the factors they were studying on the quality of the lake.

As the investigation continued, the students began to realize that the factors they were investigating interact. In one discussion, for example, the physical factors team suggested that temperature determines the number and kinds of organisms, and the chemical factors team reported that the numbers and kinds of organisms influence how much oxygen and carbon dioxide are present.

At the end of the two-month data gathering period, the groups presented their data and their explanations of the specific effect the factors they studied have on the lake. The class then began the next phase of the investigation—using the data they had gathered to answer their original set of questions, Is the city park lake polluted? If so, how have humans influenced the pollution?

As they compiled their data, the students realized that they must first address the question of what counts as pollution. They agreed that they would use the presence of coliform bacteria as their operational definition of pollution because of what they learned in their reading. Water can look, taste and smell perfectly clean and yet be unsafe to drink because it contains bacteria. Coliform bacteria live longer and are easier to detect than other bacteria that cause disease, and their presence is considered a warning signal of sewage pollution.

Working across groups, the class compiled their respective reports and prepared one major summary of their inquiry. In the summary, students capably described procedures, expressed scientific concepts, reviewed information, summarized data, developed charts, explained statistical procedures they used, and constructed a reasonable and logical argument for their answer to the question, Is the city park lake polluted? If so, how have humans influenced the pollution? The class concluded that, even though the lake experiences variations and changes in many factors, it was not polluted.

Throughout the course of the investigation, Ms. Idoni assessed her students' understanding in various ways. Prior to the start of the activity, she had instructed them to organize their journals around a modified form of the fundamental abilities for the Science as Inquiry Standard, grades 9-12 (see box). She reviewed their journals regularly, asking questions about the scientific concepts underlying their explanations, and whether they had the strongest conclusions.

Photo courtesy of Mary Hindelang, Michigan Technological University

As the investigation proceeded, she kept a mental list of which of the inquiry abilities her students were using. She also assessed her students' increased comprehension of other content standards, such as the interdependence of organisms (Life Science Standard, grades 9-12), and natural resources and environmental quality (Science in Personal and Social Perspectives Standard, grades 9-12). For a final assessment activity, she asked each student to prepare a report describing how he or she would investigate the cause of a massive fish kill in the lake, with the understanding that it is clear that coliform bacteria have not been found in the lake.

Examples at Different Levels

In addition to the vignette excerpted here, *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* includes other vignettes and examples that describe a variety of activities at different grade levels.

In one vignette, an elementary teacher capitalizes on students' questions about the differences in trees on the schoolgrounds, and guides her students in designing their own investigations. The students determine what evidence to collect to address their questions, formulate explanations based on the evidence, and gain understandings about the basic needs of plants (Life Science Content Standard, grades K-4).

In one of the examples, a teacher engages high school students in comparing studies of past and current investigations of evolution on the Galapagos Islands. In addition to learning biological evolution concepts, students develop understandings of the roles of logic, evidence, criticism, and modification in scientific discovery (Life Science Content Standard, grades 9-12).

Physical Science and Earth and Space Science are featured in vignettes describing inquiries in elementary, middle, and high school classrooms.

In total, there are five vignettes that describe classroom-based investigations in some detail, and several shorter examples of classroom inquiries. Each vignette illustrates features of inquiry described in the *National Science Education Standards*. Another five vignettes are written by teachers and describe various professional development activities and the changes in classroom practice brought about by the teachers' participation in those activities.

Assessment, Professional Development, and the Research Base

The report does more than provide snapshots of classroom activities, of ways teachers plan and fit in-depth inquiry experiences into ongoing curriculum, and of professional development experiences. The report also covers the issues that teachers confront as they try to incorporate inquiry-based activities into their classrooms, for example, how to assess student learning.

In the chapter "Classroom Assessment and Inquiry," the report describes features of classroom assessments that support inquiry and the *National Science Education Standards*. Some of these features are included in the excerpted vignette above. Ms. Idoni assesses her students' understandings during class discussions and by examining their journals throughout the activity, as well as through analysis of their group reports and individual reports on the hypothetical fishkill at the end of the activity.

One point stressed in the chapter on assessment is that the evaluation format must be appropriate for the material being assessed: "Multiple choice and short-answer responses are convenient for assessing the things that students should know 'at the drop of a hat' or 'cold.' Many of the things valued in the *Standards*, however, require time for reflection (more than a couple of minutes). Consequently, many assessments require formats that take more time" (p. 83). The importance of formative assessment and student self-assessment as well as summative assessment is also considered in this chapter.

As evidenced by the number of vignettes describing teacher professional development activities, the report also addresses the need for teachers to actively learn to use inquiry in their classrooms. In the chapter "Preparing Teachers for Inquiry-Based Teaching," the report emphasizes the importance of providing teachers with opportunities to learn science through inquiry during their preservice instruction. If they are to successfully teach science through inquiry in their classrooms, they must experience such instruction firsthand. The chapter also underscores the benefits of continued professional development throughout a teacher's career.

Other useful resources in the report include a section with answers to frequently asked questions about inquiry, a discussion of the research base supporting inquiry learning (see resource list), and an appendix containing worksheets to aid in the analysis of instructional materials being considered for use in an inquiry-based science program.

Inquiry and the National Science Education Standards: A Guide for Teaching and Learning will provide you with a rich resource of personal examples and guidelines to aid you in designing and carrying out inquiry-based science activities in your classroom. You may read the report free of charge online (www.nap.edu/books/0309064767/html/).

Tina Winters is a research assistant in the National Research Council's Center for Education and was a member of the editorial staff there during the development of the National Science Education Standards.

Karen Hollweg is senior program officer for K-12 science in the Center for Education, and is currently directing a project on understanding the influence of standards in K-12 mathematics, science, and technology education. She has taught biology, field biology, and physical science at the middle and high school levels.

The second addendum to the *Standards*, titled *Classroom Assessment and the National Science Education Standards,* will be available in 2001. For more information about this and other resources from the National Research Council, contact Tina Winters at TWinters@nas.edu

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There Are Standards and Then There Are Standards

Students are not the only ones facing tough new challenges. This article provides a glimpse at the National Board for Professional Teaching Standards (NBPTS).

by Judy Spicer, ENC Instructional Resources

This is the best way to fine-tune my teaching practice. I began working toward a PhD in science education, but quickly realized that I wanted to be engaged in a process that would focus on my teaching practice. I decided that pursuing certification through the National Board for Professional Teaching Standards is the way to go.

—Laura Brennan, high school chemistry and physical science teacher

After a decade or more of top-down efforts to reform education, the fact that there has been little substantive change at the classroom level is a bitter pill for many to swallow (Slavin, 1998).

John Goodlad, head of the Center for Educational Renewal at the University of Washington in Seattle, can't stand the word *reform*. "The word implies bad people who need to be reformed. And that is part of the reason that school reform is doing so badly—people doing things for other people, rather than people doing things for themselves," said Goodlad, whose prescription for better schools emphasizes raising teacher quality (Strauss, 2000).

The 4,800 plus teachers who have earned certification from the National Board for Professional Teaching Standards (NBPTS) are taking personal responsibility for improving teaching and student learning, the ultimate objective of all school reform. In support of the National Board, President Clinton stated a goal of having a National Board Certified Teacher in every school in the United States. He remarked that he envisioned the need to have the certificate presentation ceremony in the Rose Bowl, rather than the Rose Garden, to accommodate the increased number of successful applicants.

What Is the NBPTS?

In 1986 the Task Force on Teaching as a Profession of the Carnegie Forum on Education and the Economy recommended the formation of a board to oversee the development of national professional teaching standards. Representatives of the major teacher organizations, elected officials, and education experts established the NBPTS as an independent, nonprofit, non-government organization with a 63-member board of directors, the majority of whom are classroom teachers. Funding comes from foundations, the federal government, and fees paid to participate in the certification process.

NBPTS aims to establish a teacher career path that rewards increasing proficiency and to promote accountability in the classroom. The Board sets rigorous standards for what accomplished teachers should know and be able to do, operates a national, voluntary system to assess and certify teachers who meet these standards, and works to advance related education reforms for the purpose of improving student learning in America's schools.

National Board Certified Teacher Chris Ault works with her students.

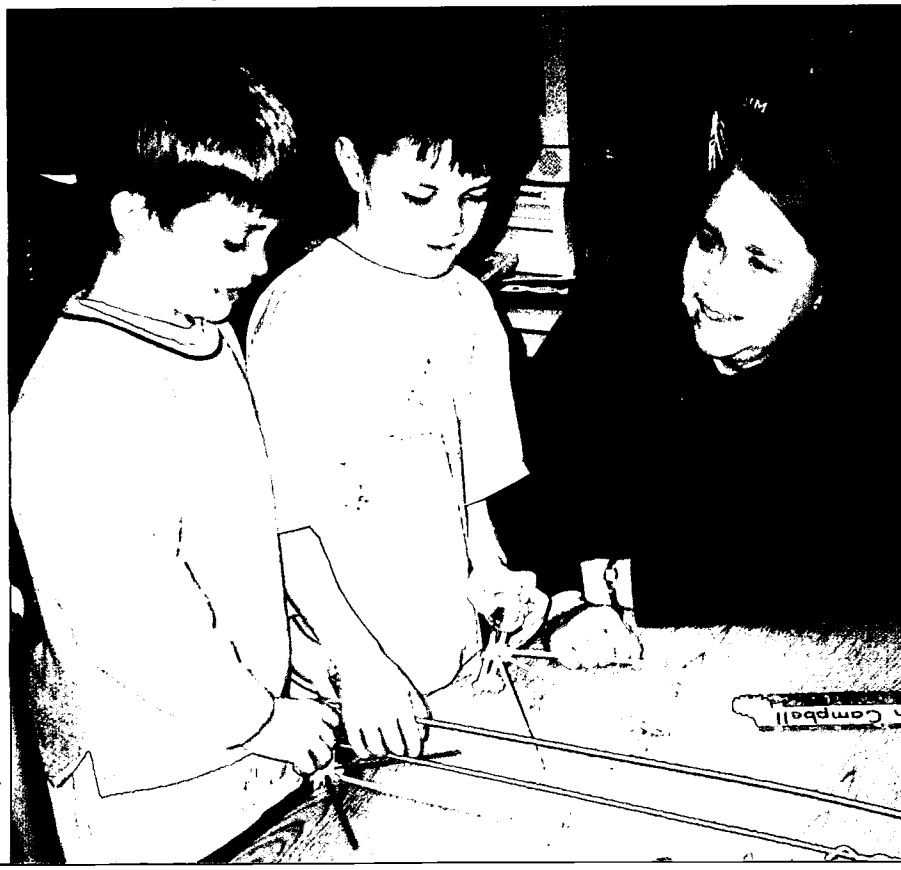

Photo by Jan Reitzel

How Does the NBPTS Support the Improvement of Teaching and Learning?

The National Board has developed advanced standards for experienced teachers in 21 fields. Meeting these standards leads to designation as a National Board Certified Teacher. This certification, and the standards on which it is based, is structured around student developmental levels (early childhood, middle childhood, early adolescence, adolescence, and young adulthood) as well as by subject area.

The standards grow out of the National Board's central policy statement, *What Teachers Should Know and Be Able to Do*, which outlines what the National Board values and what it believes should be honored in teaching. This statement describes a vision of teaching based on five core propositions:

1. Teachers are committed to students and their learning.
2. Teachers know the subjects they teach and how to teach those subjects to students.
3. Teachers are responsible for managing and monitoring student learning.
4. Teachers think systematically about their practice and learn from experience.
5. Teachers are members of learning communities.

Profile of a National Board Certified Teacher

Ask early childhood educator Chris Ault why she sought the NBPTS certification in 1995 and she will tell you she wanted to know if she was on the right track in her teaching. During the yearlong certification process, Chris learned the value of self-reflection and collaboration with peers as she examined her teaching practice.

As a result of her work toward certification, Chris realizes that not only do her peers think of her as a skillful teacher, but that she meets a high national standard of excellence. Chris' NBPTS certification and participation in a White House reception hosted by President Clinton during the first Annual National Board Teachers Meeting symbolize her confidence and pride in her teaching accomplishments. The thinking that resulted in her certification has become such a part of Chris's approach to teaching that she frequently examines the what and why of her daily lessons against the standards set by the Board.

Asked if the related financial rewards made the process worth the effort, Chris has a few surprising answers. She believes that the self-knowledge and understanding of teaching that a candidate gains in the process are the most significant benefits. Because of what candidates learn about their teaching and about student learning, Chris is sure that the certification process is extremely valuable even for the approximately half of the candidates who do not qualify for certification. She also notes that a teacher candidate's commitment to the process is huge and, to be successful, must go well beyond the lure of financial rewards. Other benefits to being an NBPTS certified teacher, according to Chris, include networking with great teachers from around the country and opportunities to provide professional leadership.

What Does the Certification Process Involve?

The NBPTS's performance assessment for teacher candidates is based on standards particular to each of the 21 presently available certifications. The assessment fee for 2000-2001 is $2,300. Support is available from candidate subsidy programs funded by some states, from local school districts, and from other private funding sources.

The assessment consists of two components:

- A portfolio containing videotapes of classroom teaching, samples of student work, and written commentary.
- A daylong summer session at an assessment center during which the teacher candidate completes written tasks designed to complement the portfolio. This set of exercises gives candidates the opportunity to demonstrate both content and pedagogical knowledge in the certification field.

How Does the NBPTS Address Other Educational Standards?

The NBPTS certification process does not directly address the standards developed by the National Council of Teachers of Mathematics and the National Research Council. However, the practices supported in the certification process reflect the national standards in calling for teaching mathematics for understanding and engaging in inquiry-based science.

High school science teacher, Betty Altfater, who is applying for the NBPTS science certificate, feels that work on her portfolio focused her attention on the national standards for her students. For example, as part of the certification process, Betty is required to show how she uses assessment of student work to further learning goals and facilitate students' individual growth as science learners. She must collect assessment artifacts, student work samples, and written commentary to describe, analyze, and reflect upon how she approaches assessment to further instructional goals. Betty believes that the need to examine assessment practices and to prepare rubrics for her classes will be one of the most worthwhile outcomes of the certification process.

Impact of the NBPTS

Is National Board Certification the magic bullet needed to improve K-12 education in the twenty-first century? Of course not. However, if it is true that quality teaching focused on student needs and knowledge of content and pedagogy are key to helping children learn, then National Board Certification represents movement in the right direction.

The NBPTS is not without controversy. Detractors question whether the outcomes of the process warrant the required expenditure of time and money. Time will tell.

In the meantime, a press release from NBPTS presents results of a study, conducted by the University of North Carolina at Greensboro, that compares teaching and learning in classrooms taught by National Board Certified teachers with that in classrooms of teachers who were unsuccessful when applying for certification. The study validates the certification process by showing statistical differences between the two groups of teachers on 11 of 13 commonly held dimensions of teaching expertise. In addition, the study shows that 74 percent of students in the NBPTS certified teachers' classes achieved a higher level of comprehension based on random samples of student work compared with only 29 percent of students in classes taught by unsuccessful candidates.

For further information consult the NBPTS web site (www.nbpts.org/).

Or contact NBPTS at one of their two locations.

Arlington, Virginia:
1525 Wilson Boulevard
Suite 500
Arlington, VA 22209
(703) 465-2700
Fax (703) 465-2715

Sonthfield, Michigan:
26555 Evergreen Road, Suite 400
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Student Learning Groups that Really Work

Standards-based instruction calls for students to work with their peers. Here are some ways that teachers can enhance the effectiveness of group work in their classrooms.

by Carol Damian, ENC Instructional Resources

When I am in the classroom, striving to help all of my students understand science content and processes, I often group students so they can share ideas, discuss data, address difficulties, and create "ways to find out." One of the principal challenges to this strategy is that learning groups take time. In terms of just "time efficiency," it may seem easier and more practical to put the students back into rows, tell them all the information they should learn and understand—and hope that they do.

Unfortunately, research and practice tell us that while this sit-and-listen method may be more time efficient, students don't really learn and understand. Information must be processed, and each student processes a little differently. Research by David and Roger Johnson (2000) of the

Teachers need to have a chance to collaborate, too....

The *National Science Education Standards* (NSES, National Research Council, 1995) and the *Principles and Standards for School Mathematics* (PSSM, National Council of Teachers of Mathematics, 2000) emphasize the need for establishing collaborative learning groups for teachers as well as students. The Professional Teacher Standards of both NSES and PSSM stress the advantages when teachers collaborate to improve their own teaching skills and content knowledge. The feeling of isolation is reduced when a teacher invites a colleague to observe his/her practice and then the two engage in nonthreatening, confidence-building dialogue about what worked and what could be improved. According to both NSES and PSSM, strong collegial support leads to systemic improvement. For students and teachers, collaboration brings a feeling of belonging and deeper meaning to the learning process.

University of Minnesota indicates that when students are actively involved in meaningful group work, their learning is retained, while work done individually tends to be less in-depth, more memorized, and soon forgotten. It takes a variety of experiences along with active involvement in knowledge-building if all learners are to understand concepts and retain knowledge.

That is why the *National Science Education Standards* (NSES, National Research Council, 1995) and the *Principles and Standards for School Mathematics* (PSSM, National Council of Teachers of Mathematics, 2000) emphasize the need for establishing learning groups or "learning communities." Our job as teachers is to use learning groups as effectively—and efficiently—as possible.

Effective Groups Have Much in Common

As a teacher I know that there are different ways to plan and implement student grouping, and I recognize that they are not equivalent. On the other hand, I have also found that effective learning groups of any type have a great deal in common. All types of learning groups must be student-active and teacher-intensive. Work done in such groups must be academically rigorous and meaningful—it should not represent a "dumbing down" of learning goals. Teachers and students must understand that learning groups are not primarily social gatherings (although they can promote positive interactions among participants); that they do not operate without structure, monitoring, and instruction; and that they are not easy (especially at first!).

No matter which group process is used, goals for learning must be understood by everyone in the class from the start. Timelines must be clearly defined. The expectations for the end-products (from the individual student and the learning group) must be explained. Students must understand how their work will be assessed at the end and throughout the group work. The teacher has an ongoing task of providing resources, monitoring for progress, and assessing the quality of work as it proceeds.

To work most effectively, all types of groups should be heterogeneous, containing students with diverse learning backgrounds, multiple ways of thinking, and varied ways of communicating ideas and information. It is extremely important that all students (not just a few) are actively involved in the group and take responsibility for their own learning. Finally, no matter which type of group you choose, cooperation is valued over competition, and students have a sense of being able to accomplish more learning together than they can alone.

Photo: PhotoDisc

While acknowledging these similarities, I have learned to differentiate three types of learning groups: problem-solving partnerships, cooperative teams, and collaborative groups. In the process of using all three types with students, I have found each strategy to have advantages for specific learning goals.

What does a classroom look like when each of these different types of student groupings is used? What are the students and teachers doing? How do you as a teacher weigh the advantages and disadvantages of different types of student groups to meet different instructional purposes?

The remainder of this article will help answer those questions. The chart on page 27 provides a list of characteristics shared by effective student learning groups and a summary of the attributes of each of the types.

Problem-Solving Partnerships

These groups usually consist of two or three students who are given a math- or science-related problem and then asked to find a way (or ways) to solve it. Partnerships of this kind are usually of short duration—one class period or less—but they can last for several class periods depending on the assignment. For example, partners can be assigned a class problem set that takes longer to complete and may involve multiple approaches or steps.

What does the teacher do to ensure that these partnerships are successful? For any problem-related topic, the teacher introduces background information, builds conceptual and procedural structure, re-teaches, ties information together, and offers resources. While the partners are meeting, the teacher moves from group to group asking "have you tried this?" or "what would happen if?" types of questions, checking for progress, and monitoring participation. At the conclusion of the activity, the teacher's role is to help guide discussions as different group proposals for solutions are presented.

In my own teaching, I find Problem Solving Partnerships to be a rewarding method for students to apply their knowledge of mathematics and scientific principles to problems that could be encountered in life or work situations. Students in my classes become comfortable with this way of wrestling with challenging problems because they have other students to help them

Continued page 28

Grouping That Leads to Real Learning

Common Characteristics of All Types of Effective Learning Groups

Work done in groups is challenging and meaningful.

The teacher is always actively involved in the students' learning process, serving as a resource person, questioner, guide, evaluator, and coach.

Learning goals and timelines are clearly understood by the students and monitored by the teacher.

Groups are heterogeneous, and all students are actively involved.

Cooperation is valued over competition.

Students have a sense of being able to accomplish more learning together than they can alone.

The group process provides a comfort level for discussion and airing questions.

Student interaction and social skills are required, but the purpose of grouping is not primarily social. Group time is not "free time" for student (or teacher).

Multiple means of assessment are possible (rubrics, portfolios, quizzes, interviews, presentations, etc.). Evaluation can be of the individual student, of the group, or a combination of these.

Three Learning Group Strategies

Problem-Solving Partnerships	Cooperative Teams	Collaborative Groups
Two to three students per group.	Three to four students per group.	Three to six students per group.
The duration of group work is short (part of a class period to a few days).	The duration of group work ranges from several days to several weeks.	The duration of group work can be short (days) or longer (weeks or even months).
The specific task or problem to solve is limited in scope (a single problem or question or a limited set) and is usually a challenge or practice activity for students to apply recent learning.	The problem or task is clearly defined by the teacher.	The task or problem is open-ended and may cover large amounts of course content.
Multiple approaches to solving the problem are encouraged. There is no single "right" way to solve most problems, and all reasonable solutions or answers to the problem are honored. Individual students have an opportunity to explain and discuss their suggested solutions as well as their misconceptions. New understandings are developed by the individual, by the team, and, finally, by the whole class. Group and class discussions (and solutions) provide immediate feedback to the student.	A team plan of operation and goals is specified, and teams are highly structured. Each student has a clearly defined role in the team such as recorder, questioner, reporter. The teacher takes time to teach each student role. Team members share leadership within the framework of specific roles. All team members must contribute or the team cannot progress. (Teams "win or lose together.") The end product represents the entire team. The team focus is on cooperation as well as on achievement of goals. Awareness of the group process is as important as completing the task.	Student roles are flexible and may change throughout the project or assignment. Students observe (and help with) other students' work, and critique, evaluate, explain, and suggest ways for improvement. Open communication and multiple approaches are emphasized. All students are involved in honest discussion about ideas, procedures, experimental results, gathered information, interpretations, resource materials, and their own or other students' work. Students are constantly aware of the collaborative communication process, as well as the product or goals. They know they can change direction to meet goals.

bounce ideas around and it's okay to try a method that is "wrong" as long as it helps lead to something that works.

Problem Solving Partnerships are especially effective when students are required to apply new knowledge. Here are some examples:

- Math students have just learned how to find the equation for a certain kind of graph and then are given sample graphs to solve.
- Biology students have learned about DNA structure and replication, then are asked to predict the sequence of nucleotides in daughter strands from several different parent strands.
- Chemical science students have learned about chemical reactions and conservation of mass, then are asked to balance chemical equations.
- Elementary students have learned about classification and are asked to sort items into categories.
- Middle schoolers have learned about manipulating algebraic equations and are asked to solve for different variables.

Cooperative Teams

By design, Cooperative Teams are the most structured of the three types of student learning groups. Generally, the teacher chooses a task that leads to a clearly defined product. Teams are made up of three or four students, each assigned a role such as recorder (monitor), manager (facilitator), skeptic (questioner), or reporter. One member of the group cannot complete the task without the contributions of all the other members. They truly must co-operate (mutually operate) to accomplish their learning task.

In this design, it is essential that the teacher not only clearly define the roles but also explicitly teach them. It does not work to assign students to a Cooperative Team, to give each a role to perform, and then to leave the Team to get the job done. Even if the goals, products, assessment and other factors are clearly understood, if any student's job (role) is unclear, the group cannot function. In Cooperative Teams, the process is just as important as the product, perhaps even more so.

Johnson & Johnson (2000) claim that educators are kidding themselves if they think that teacher instructions to "work together," "cooperate," and "form teams" will automatically be followed by cooperative work among the team members. They remind us that not all groups are cooperative. In some cases, they can be quite competitive and even disruptive to learning.

For my classes, Cooperative Teams are especially useful when the assigned task is somewhat complex, but fairly well-defined. The plan works well when students are expected to carry out a laboratory or hands-on activity, where procedures are clearly specified, the kinds of data to be gathered are identified, and the conclusions to be reached are rather straightforward. Cooperative Teams work well in the following situations:

- Elementary students have learned about "sink and float" and are asked to test several objects in a tub of water, then report their findings and conclusions.
- Middle school students have been studying simple machines, then are asked to complete a certain laboratory activity using ramps and pulleys and report the results.
- Math students are learning about perimeter and area and are to do an exercise where they measure many objects, carry out necessary calculations, and draw conclusions about these objects.
- High school students engage in a prescribed set of activities in which they use a motion detector and graphing calculator (or computer) to determine the velocity or acceleration of a moving body, then report their findings.

The essential ingredient to making classroom learning effective through Cooperative Teams, according to the Johnsons, is to carefully teach what cooperation is and how it works in well-designed learning groups. Essential components of cooperation include positive interdependence, face-to-face interaction, individual and group accountability, interpersonal and small group skills, and group processing (Johnson, Johnson, & Holubec, 1993). Their position, based on years of research, is that when teachers carefully design these elements into classroom group instruction, student learning is enhanced and lifelong skills are developed and reinforced.

Collaborative Groups

In my teaching, I find that this group structure allows for high levels of flexibility and creativity. Groups of three to six students work together over periods that may range from days to even months. The process allows for handling large amounts of course content using a constructivist approach. Collaborative Groups are an excellent way for students to apply what they have learned with support from their peers.

Garmston and Wellman (2000) identified Seven Norms of Collaborative Work: pausing, paraphrasing, probing, putting ideas on the table, paying attention to self and others, presuming positive intentions, and pursuing a balance between advocacy and inquiry. When these norms are embedded in classroom work, they can serve as powerful tools for learning.

What are the advantages of Collaborative Groups for students? Because there is peer support for learning and the group has extended periods of time to think and work together, motivation generally runs high. Students become energized to find information, try new methods to solve problems, and discuss successes and failures as they attempt to complete the project. As they discuss their experiences in

their groups (and also across groups), they build understanding, peer respect, and self motivation. Through differences in perspective and honest discussion, students truly can accomplish together what they cannot possibly do alone.

The Collaborative Group instructional method, while student-active, also provides an opportunity for high-energy, exciting involvement for the teacher. Asking leading questions and guiding students to answer their own inquiries are major components of the teacher's role. When working with these groups, I never have a moment of free time in class, but find myself totally consumed with my deep engagement with the students.

I find these situations to be particularly suitable for Collaborative Groups:

- Elementary students have been learning about mammals and are to gather information about these animals from a variety of sources, then construct an informative poster and compile a report to present to the class.
- While learning about water as a necessary, but limited, natural resource, students contact local water purification systems people, research water sources, and investigate their community's water distribution system to learn as much as possible about local water use factors; they then write a proposal for improving these factors with the goal of conserving water.

Photo: PhotoDisc

- Students research facts, history, and options about a suggestion for construction of a fast-rail system to connect two distant cities; they then prepare and carry out a debate about the feasibility and/or advantages and disadvantages of the proposed system.
- Other useful types of collaborative activities include brainstorming, role-playing, peer review or editing, jigsaw sharing, and web-based projects (see "Using the Internet: Connecting Students Through Collaborative Projects," page 10).

Collaboration is communication about relevant information and processes; it is purposeful and promotes deep understanding of subject content. Throughout NSES and PSSM, collaboration is encouraged as a way to build a community of learners that starts in schools, then expands to neighborhoods and workplaces.

Grouping That Leads to Real Learning

A dominant theme in both NSES and PSSM is that all students can learn and must have appropriate opportunities to study mathematics and science as active participants in the learning process. Students are expected to master content and processes, develop the skills to apply their knowledge to real situations, and learn how to learn for lifelong benefit. The use of teacher-directed student learning groups in the classroom is an effective way to help achieve all of these educational goals.

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Inside the Minds of Six Year Olds

The new mathematics standards call for teachers who can help students become resourceful problem solvers. Here is the story of a preservice teacher's search for ways to understand first graders' approaches to problem solving.

by Edward Mooney and Cheryl A. Lubinski, Illinois State University, in collaboration with Paul Saaty, Glendale, California

Authors' Note: Paul Saaty's purpose for asking us to join in writing this article stemmed from his first days as a beginning teacher. He met several teachers who expressed their confusion when their students could solve some mathematics problems but not others. Paul felt that sharing what he learned during his preservice days might help others.—EM, CAL

In the first chapter of *Principles and Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM) envisions classrooms in which students conjecture, reason, and talk about their strategies for solving problems. For teachers, achieving this vision can seem to be an overwhelming task.

As teacher educators, we try to help preservice teachers understand the importance of assessing students' reasoning. Research can help us understand how students learn and think about mathematics, but integrating such information into practice is difficult. In this article, we follow one of our preservice teacher-students, Paul Saaty, as he puts into practice what he learned from published research about teaching mathematics.

Paul was an elementary education major who had a solid knowledge of mathematics content. He had studied Carpenter and Fennema's research (Carpenter, Fennema, Franke, Levi, and Empson, 1999) on Cognitively Guided Instruction (CGI) in his methods course. He had read about primary-age students who could solve simple word problems; at first, these students modeled the action of a problem and then acquired more complex strategies as they gained experience. He understood that some of these learners would be between levels of development, forcing them to resort to a less mature strategy depending on the type of problem they encountered.

Paul read about teachers using a chart from the CGI research *(Figure 1)* to extend the variety of addition and subtraction problems beyond those found in the typical primary textbook. A variety of problems encourage children to use a variety of strategies. From the research, Paul learned that these problems differ by the position (end, middle, or beginning) of the missing quantity. Also, some problems imply

Join	**Result Unknown** You have 3 stickers. Your mother gives you 5 more. How many stickers do you have now?	**Change Unknown** You have 4 pennies. Your mother gives you some more. Now you have 11 pennies. How many did your mother give you?	**Start Unknown** You have some money. You get $3 so that you now have $8 to go to the zoo. How much money did you start with?
Separate	**Result Unknown** You have 12 cookies. Your friend eats 3 of them. How many cookies do you have now?	**Change Unknown** You have 12 apples. A friend takes some and eats them. Now you have 8 apples. How many apples did your friend take?	**Start Unknown** You have some cookies. A monster eats 4 of them so now you have 7 cookies. How many cookies did you start with?
Part-Part-Whole	**Whole Unknown** You have 4 blue crayons and 6 yellow crayons. How many crayons do you have?	**Part Unknown** You have 14 crayons. 8 of these are red and the rest are green. How many are green?	
Compare	**Difference Unknown** You have 13 cookies. Your friend has 8 cookies. How many more cookies do you have than your friend does?	**Compare Quantity Unknown** You have 7 crayons. Your friend has 3 more crayons than you. How many crayons does your friend have?	**Referent Unknown** You have some dimes. Your friend has 3 more dimes than you do. If your friend has 12 dimes, how many dimes do you have?

Figure 1: Chart format adapted from Children's Mathematics: Cognitively Guided Instruction *by Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Emperson. Copyright (C) 1999 by Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Emperson. Published by Heinemann, a division of Reed Elsevier Inc., Portsmouth, NH. Used by permission of the publisher.*

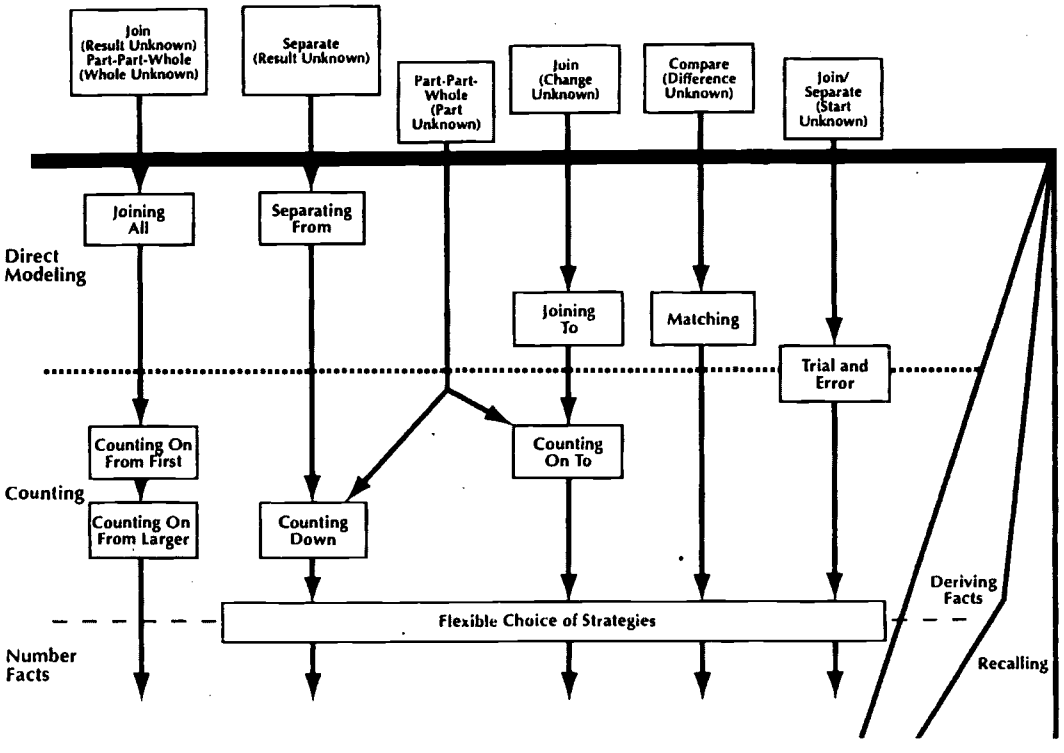

Figure 2: Reprinted from Children's Mathematics: Cognitively Guided Instruction *by Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Emperson. Copyright (C) 1999 by Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Emperson. Published by Heinemann, a division of Reed Elsevier Inc., Portsmouth, NH. Used by permission of the publisher.*

action (Join and Separate problems) and some do not (Part-Part-Whole and Compare problems). Understanding differences among the problem types is crucial to understanding the strategies students use to solve problems *(Figure 2)*. For example, young children have more difficulty thinking about problems without action than problems with action; direct modelers and counters have difficulty thinking about a strategy to solve a Start Unknown problem.

During his student teaching, Paul wanted to put what he was learning in his mathematics methods course into practice. For his research project, Paul formulated an instructional plan for two first-graders, Jackie and Joel, based on his interviews with the children.

Working with a Direct Modeler

Direct modeling is a strategy commonly used by children in the primary grades. The student models or acts out each part of the problem as he or she works toward a solution.

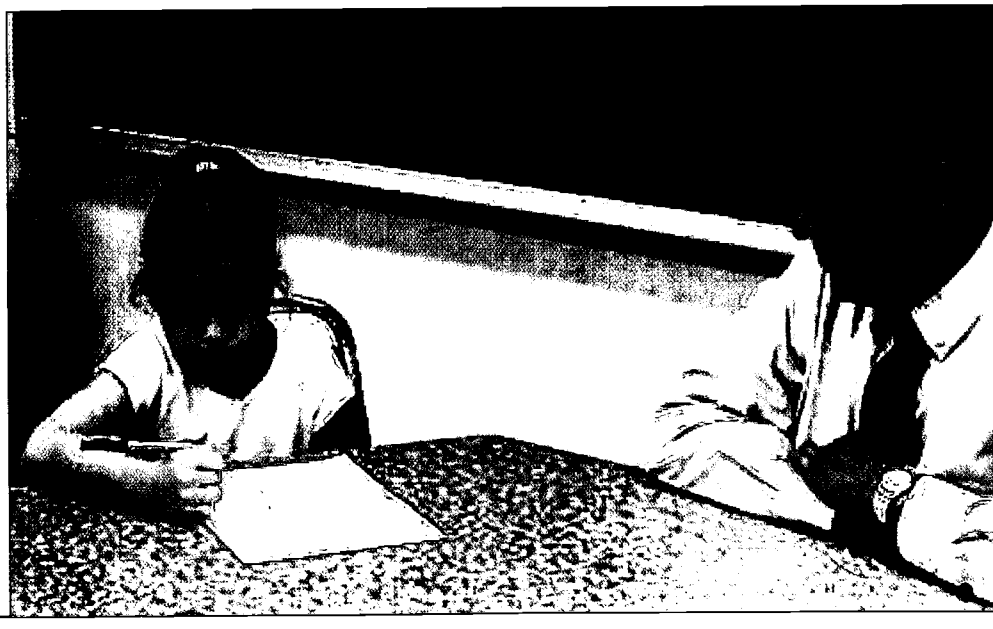

Photo courtesy of Diane Brewer, Illinois State University

Students may move their fingers or objects to directly model the action suggested in the problem. They do this even though the strategy has not been modeled for them.

Jackie was successful in solving the Join (Change Unknown) problem by making four tally marks and counting them aloud. She continued to join tally marks until she reached 11 *(Figure 3)*. She counted the tally marks that she had added to the initial four and found that her answer was seven. This direct modeling strategy is known as Joining To. Jackie used the same strategy to solve other Join (Change Unknown) problems.

In looking at Jackie's tally marks, Paul saw that the marks displaying the initial quantity were separate from the marks of the missing quantity. This is significant because it indicates the ability both to plan ahead and to understand the relationship among the numbers. Less-mature direct modelers may not initially keep the groups separate and would need to go back and separate the two sets. As students have more problem-solving experiences, they learn to separate the two sets.

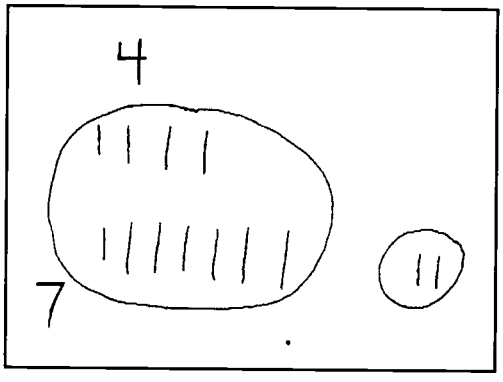

Figure 3: Jackie's work for the Join (Change Unknown) problem

Paul gave Jackie a Separate (Change Unknown) problem. To solve this problem, Jackie drew 12 tally marks and then crossed out eight of them. She counted the remaining tally marks to arrive at the answer. Although this was a correct answer, the solution strategy is not that of a direct modeler because it does not model the structure of the problem. Drawing 12 tally marks and taking away marks until eight were left would be directly modeling the structure of the problem. Jackie's strategy did not correspond to the action in the problem, reflecting more flexibility in her thinking. It is important to note that direct modelers cannot typically solve Start Unknown problems with understanding because they do not have a flexible use of strategies that reflect a deeper understanding of number relationships.

Young children who do not understand the relationship of number facts they memorize do not often use facts in problem-solving situations. Paul wanted to help Jackie develop more flexibility in her thinking, so he gave her problems that involved only the numbers three, five, and eight. He used numbers that would be familiar to Jackie so she could concentrate on the relationships among the numbers rather than on the computations. Although he varied which of these numbers was missing in the problem, he started with a Join (Result Unknown) problem then moved to a Separate (Result Unknown) problem. These two problem types are the easiest to solve because they can be directly modeled.

Jackie was given several problems that were Join or Separate (Result Unknown) and another several that were Join or Separate (Change Unknown). All problems included the numbers three, five and eight. Jackie modeled each problem, drawing lines or circles. She did not recognize connections among the numbers on her own. Paul had to probe. He asked her what she noticed about the numbers in the problems. She noted, "Each problem has a five."

Paul realized that telling and showing her the relationship, that is, 5+3=8, 8–5=3, 3+5=8, and 8–3=5, would not be beneficial to her understanding at this time. These fact families would have little meaning for Jackie because she needed more experience in solving problems in which these numbers were imbedded.

Paul's role as teacher was to create situations in which understanding could be developed and to ask questions that might challenge Jackie's thinking. From this probing, he learned that Jackie needed more problem-solving experiences before she would be able to move beyond the concrete representations of numbers to thinking about number relationships. Teaching her to memorize fact families would not have been an appropriate instructional decision at the time. As Jackie begins to develop counting strategies and moves on to deriving facts, her ability to see number relationships may develop to the point at which she is aware of the relationship of numbers, or fact families.

Research suggests that direct modelers find problems that have no action, such as Part-Part-Whole and Compare problems, harder to solve than problems with action. Paul noted in his research: "Consider how many permutations exist by using addition and subtraction of the numbers zero through nine. Memorizing each permutation without understanding the relationships within each fact family would be inappropriate and could lead to forgetting."

Working with a Counter

A counter might solve the Join (Change Unknown) problem in Figure 1 by thinking about the number four and Counting On to 11, keeping track of the "count-ons" with his or her fingers and then counting the fingers used. During his interview with Joel, a counter, Paul learned more about solution strategies and how children acquire them. As he had done with Jackie, Paul asked Joel to solve the Join (Change Unknown) problem from Figure 1. To Paul's surprise, Joel solved this problem incorrectly by adding the two numbers given as if it were a Join (Result Unknown) problem. He did this by starting from the first number and counting up, "11, 12, 13, 14, 15," raising a finger on each count.

Paul did not tell the child why this was an inappropriate strategy but rather provided the problem-solving experiences necessary for the boy to construct this understanding for himself. Paul gave Joel a Join (Result Unknown) problem and

followed it with a Join (Change Unknown) problem, making the action more apparent in each situation. Joel solved the Join (Result Unknown) problem correctly and then distinguished between that and the Join (Change Unknown) problem. Having both problems to compare allowed Joel to change his solution strategy to correctly solve the Join (Change Unknown) problem. He started with the first number and then counted up until he reached the final number, raising a finger on each number he joined to the initial number. Looking at his fingers, he found his answer for how many more were given to the initial set.

Next, Paul gave Joel the Separate (Result Unknown) problem. Joel once again tried using a counting strategy, but he arrived at a wrong answer, eight. The child's difficulty was not in understanding the relationship among the numbers, but in his counting strategy. To arrive at his answer, he counted "12 [no finger extended], 11, 10, 9" with a finger extended on each count of 11, 10, 9. When Paul told him to check his answer, Joel direct modeled the situation and arrived at the correct answer of nine.

Children use both direct modeling and counting strategies at the same time until they make the transition to primarily using counting strategies. All counting strategies are not acquired simultaneously.

Paul had to plan carefully to get Joel to the next level of strategies. If Joel made the same counting mistake again, Paul might have given him chips so that he could count aloud as he counted backward. Paul's goal was to have Joel see that he must first remove the last number, in this case the 12, before taking away the others. Joel was not able to make this transition initially, and Paul realized that the boy needed more practice in the strategy that he understood.

Understanding Students' Thinking

From his reading of research, Paul knew that direct modelers need experience in making symbolic representations in order to develop the generalizations necessary to progress from using counting strategies to using derived facts. A counter might continue to use fingers or objects even though he or she realizes that the first set of numbers doesn't need to be modeled. A student faced with a problem represented by 3+8 might choose to Count On starting from the larger number; in essence, such students are using the idea of commutativity. This is an important flexibility in thinking that direct modelers don't have since they must model each number and act out the sequence of the problem. Flexibility is crucial for learning facts with understanding.

Facts should be learned through problem-solving experiences rather than by rote. Children will solve problems at their own level of understanding. As teachers, we are responsible for posing questions that challenge our students' thinking and expose them to new ideas or solution strategies.

Teachers' understanding of students' thinking is the key to mathematics teaching and should be the driving force in choices regarding curriculum and pedagogy. Paul made strong use of research, student interviews, and observations to build his understanding of Jackie and Joel. Based on his understanding of the children's problem-solving strategies, Paul was able to develop instruction to increase their level of problem solving and develop their understanding of number relationships. Listening to students' thinking is an important component of this teaching process.

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Paul Saàty has been an elementary school teacher in the Glendale area of California for the past five years.

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A Vision for School Mathematics

Imagine a classroom, a school, or a school district where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodation for those who need it. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding. Technology is an essential component of the environment. Students confidently engage in complex mathematical tasks chosen carefully by teachers. They draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress. Teachers help students make, refine, and explore conjectures on the basis of evidence and use a variety of reasoning and proof techniques to confirm or disprove those conjectures. Students are flexible and resourceful problem solvers. Alone or in groups and with access to technology, they work productively and reflectively, with the skilled guidance of their teachers. Orally and in writing, students communicate their ideas and results effectively. They value mathematics and engage actively in learning it.—from Chapter 1 of *Principles and Standards for School Mathematics*, National Council of Teachers of Mathematics, 2000. p. 3.

Concept Maps:

Finding Our Way on the Road to a Standards-Based Classroom

As in all journeys, the road to meeting educational standards begins with a single step. In this case, that step is a new instructional technique.

by Judy Ridgway, ENC Instructional Resources and Linda Saville-Rath, The Ohio State University

Okay. We admit it. For years we conducted our biology classes in a traditional didactic format. After performing our song-and-dance routines (which we thought were thoroughly engaging), we would be disheartened when our students either failed to learn the material or didn't retain it. We would lament to one another, "We're pouring our hearts out, and they're just sitting back and letting us do all of the work!"

The National Science Education Standards (NSES, National Research Council, 1996) stress that students need to take responsibility for their own learning. One way of doing this is to provide students opportunities to show their understanding of scientific concepts as the concepts relate to other aspects of their lives. Working together in small groups and sharing ideas enable students to explain, clarify, and justify what they have learned. The *Standards* state that students should be offered opportunities to express their ideas using traditional and nontraditional means (i.e., pictorially, graphically, and orally). Students come from different cultural backgrounds and have varied learning styles. The NSES recognize that teaching methods should address these variations.

Beginning Our Journey

With all this in mind, we decided to try some new techniques to address one of the most significant problems in our classrooms: our students were not making the needed connections with the big ideas in our curriculum. According to David Ausubel's (1968) learning theories, students need to connect their new ideas with concepts that they already know and understand. Joseph Novak (1998) suggests that graphic organizers, such as concept maps, are a way for students to visually represent their ideas and show these conceptual connections.

Thus, we chose to begin our journey into the age of educational reform with concept mapping. We introduced the technique with a collaborative activity in which each group produced a concept map. Since the students had already spent time in class covering the characteristics of living things, we chose this to be the topic they represented on their practice maps.

Each group was given a packet of sticky notes, an overhead transparency, and a marker. We told them to list concepts about the characteristics of living things on the notes and to try out various arrangements of the notes on their tables. When they found an arrangement that best represented their understanding of the relationships between the concepts, they were to transfer the terms onto the group's overhead and to write linking terms on the connecting lines.

According to Novak (1998), the terms linking concepts together on the maps are essential to the maps' effectiveness. These terms show the relationships between the concepts and provide the conceptual glue that binds the ideas together. Without the linking terms, the concepts are just a set of vocabulary terms that are arranged on paper. Even though the students were familiar with the introductory activity's topic and we emphasized the importance of the linking words, the students struggled with the concept. This should have been an indication of the troubles that were ahead.

The Test Drive

Our next step was to ask students to construct maps on the topic of photosynthesis. Figures 1, 2, and 3 show examples of what the students produced. These three maps illustrate that the students were at different levels in terms of their understanding of the concepts as well as their proficiency at using the tool.

The concept map in Figure 1 was constructed collaboratively by three students. The map shows that, while they had some grasp of photosynthesis, there were misconceptions and holes in their understanding. For example, they clearly knew the parts of the chloroplast, but their idea that "water and sunlight makes photosynthesis" showed that they had not achieved meaningful learning. We noticed that these students seemed more intent on having a "product" than in

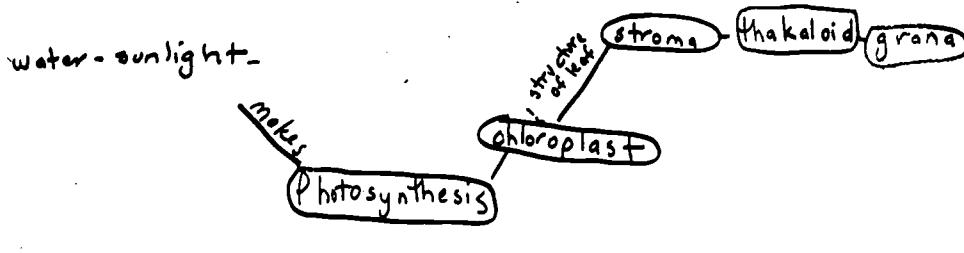


Figure 1. Concept map showing students' misconceptions.

constructing a map that helped them understand the concepts.

Figure 2 shows a map constructed by an individual student. This map demonstrates that she could logically arrange the terms associated with photosynthesis. However, without linking terms, her graphic communication was incomplete. It was unclear whether she has deeper understanding than the first three students. The linking terms she did use indicate her difficulty in determining appropriate relationships between the concepts. If she had added linking words, perhaps she would have solidified her learning.

The use of linking words by the student who completed the map shown in Figure 3 gave us a more complete view of her understanding of photosynthesis. Although her understanding was not entirely accurate, her linking words showed us the areas where she needed help. The complexity and web arrangement indicate that she was integrating the information on several levels.

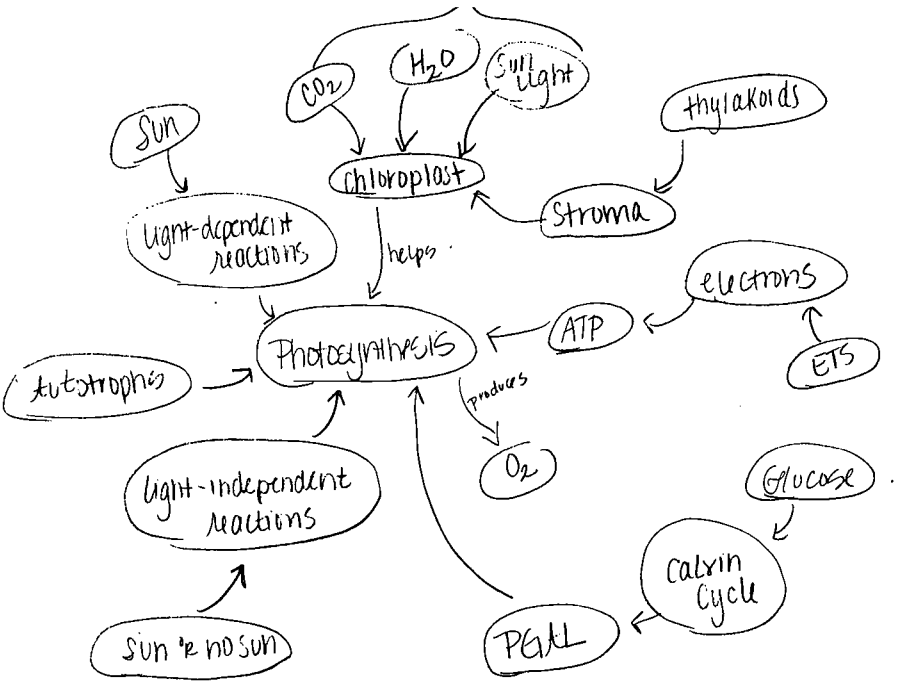


Figure 2. Without linking terms, this concept map is incomplete.

In all three cases, the mapping gave students an opportunity to concretely represent their understanding. It allowed them to reflect on what they knew and to take some responsibility for their own learning.

One of the most beneficial parts of the mapping process was the way the products focused the students' class discussions. These discussions began with the students standing in front of the class and explaining the reasoning behind their constructions. As they spoke, they often caught their own mistakes. Classmates asked questions that further drew attention to problem sections of the map. As in any discussion, being exposed to others' perspectives helped clarify and enrich the participants' ideas.

In addition, both the concept maps themselves and the students' presentations and discussions were extremely valuable as formative assessment devices. Careful analysis of students' understandings helped us shape our instruction to meet their needs.

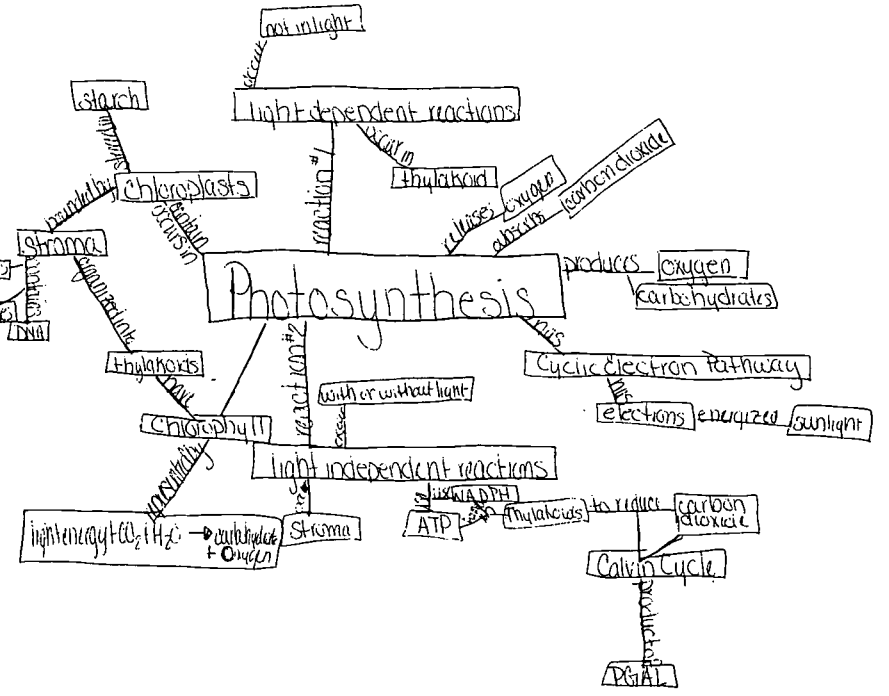


Figure 3. Although the content of this map is not entirely accurate, its complexity reflects the depth of the student's understanding.

Potholes in the Road

Since the experience was our first time test-driving the concept mapping process, we ran into several potholes. The first pothole we faced was that the students needed to have more prolonged exposure to the technique before they became proficient. They often spent too much energy trying to figure out how to organize the maps and not enough time analyzing the content behind them.

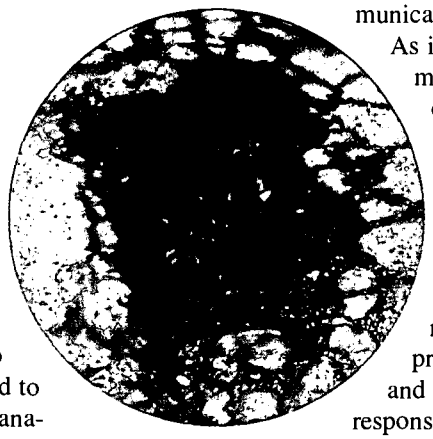
Perhaps because of the time factor, many students never stretched themselves to find the appropriate connecting terms. Because they didn't take advantage of the full power of the tool, some students felt that the mapping exercises were a waste of time or busy work.

Another problem was finding enough class

time to fully discuss the student-generated maps and to allow groups to work together. It is often hard for teachers to give up class time to try out a new method. They are often concerned that the required content will not be covered even if the new technique has the promise of helping the students learn the material.

Perhaps the deepest pothole of all was students' resistance to taking responsibility for their own thinking and learning. Most of the students had become comfortable in their role as vessels to be filled with information by their teachers, and it was difficult for them to readjust their approach.

Patching the Potholes



Even though we had these problems, we both feel that student-centered approaches in general and concept mapping specifically can be educationally powerful. So how are we going to patch the potholes in our facilitation of our students' learning experiences?

One patch would be to give students more instruction in creating concept maps. We believe that it is important for teachers to repeatedly model the technique, but they need to be careful not to map concepts students will analyze later, on their own. The danger is that students will parrot the material back with little understanding. However, we suggest using maps occasionally to present small parts of material being studied. Teachers can also facilitate group mapping exercises by helping out when students are stuck in one of the potholes. These activities should decrease as students become more proficient.

The students also need opportunities to reflect on their understanding of the course content through the use of less complex graphic organizers and then move on to small concept maps that concentrate on a specific topic. For example, instead of designing a concept map about photosynthesis, students could develop small maps for topics such as chloroplasts, light reactions, and dark reactions that allow them to break the process into manageable chunks.

Students need help to learn to connect interrelated concepts and to think about the mapping process in a metacognitive way. As they slowly acquire those skills, their concept mapping will be more effective and more valuable. Scheduling classroom time for these opportunities is important to the technique's success.

Sometimes you need a gimmick to capture interest. In the computer age, some students may be turned off by looking at handwritten papers or transparencies done by others or even by themselves. Use of Inspiration software is one way to generate concept maps that may appeal to the technical side of many students.

Finally, once the NSES become the norm in our schools, students will be more comfortable with taking responsiblity for their own learning. If their whole educational experience has been student centered, then it won't be such a shock when they are in a class with expectations for high levels of involvement.

Next Steps

Not all educators agree about the best ways to use concept maps. For example, Novak (1998) suggests that they can be used as a learning tool and a way to communicate understanding to the teacher. Barnekow (1998), on the other hand, states that even though graphic organizers are excellent communication tools, they should be used only as a way for the students to learn, not as a way for the students to communicate what they have learned to the teacher.

As is the case with any teaching and learning method, it is important to customize the use of the tools in any way that improves meaningful learning for the students.

Would we try to use concept maps in the future to help our students learn? Yes. Although our students and we struggled, we have confidence that everyone would feel more comfortable and proficient with more practice. Our past experience has proven that didactic methods are insufficient and that teachers need to give students more responsibility as well as opportunities to reflect on their own learning. Concept maps can help achieve both of those goals.

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Linda Saville-Rath taught general biology for majors and nonmajors at Columbus State Community College for 18 years. She is currently teaching microbiology at The Ohio State University and is editing life science chapters for a middle school science text.

The information for this article was gathered while the authors were teaching a class at Columbus State Community College.

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A Snapshot of Assessment in a Standards-Based Classroom

The author, who was a member of the NCTM Standards 2000 Writing Team, uses a single classroom activity to show how assessment provides guidance for the learning journey.

by Carol Midgett, University of North Carolina at Wilmington

In a Standards-based classroom, assessment is an integral part of instruction and is aligned with the curriculum. The teacher collects evidence of the students' knowledge, their ability to use that knowledge, and their disposition toward learning. Student performance is monitored to promote learning, to adjust instruction, and to report progress. Students evaluate their own learning using criteria specific to the activity. The following "snapshot" of a typical activity in a first-grade classroom shows these practices in action.

Working in pairs, the children in Linda Cummings' class are measuring objects in the room using pencils, paper clips, or straws as the measuring devices. While Susan measures the width of a tabletop, Terrence records their activity by drawing a picture of the table and labeling its width. Kyle randomly places the pencil across the top of the table without noting where the end of the pencil was placed previously. Kristen and Kevin use chalk to mark the point where the pencil ended before.

Ms. Cummings moves about the room observing students' actions, asking questions, listening to conversations, and making notes. She writes the names of students who demonstrate that they understand iteration of a unit and those who do not. Ms. Cummings makes anecdotal notes about a conversation between Hosea and Shaniqua, who wonder if their measurements would be the same if they used a sharpened pencil. She records the appropriate use of mathematical vocabulary and notes concepts that need clarification.

When the activity is complete, Ms. Cummings refers students to the rubric posted on the board at the beginning of the lesson. She reminds them of the learning target: using iteration of a unit when measuring. The rubric gives four levels of performance: expert, novice, apprentice, and beginner. It also describes what students are doing at each level. The students are asked to review their records, or drawings, and determine their level of performance. The children discuss what they did and compare the different ways they measured objects.

The children put their records in their folders. (They will share these with parents at student-led conferences.) Ms. Cummings labels each student's product with a statement of the learning objective and a description of the task. During her planning time, Ms. Cummings refers to the data she gathered today and plans tomorrow's lesson. She remembers that Hosea and Shaniqua need an additional challenge—to compare lengths when using a sharpened and unsharpened pencil. She matches Kyle with another, more accomplished partner.

The assessment practices in this classroom are consistent with the *Principles and Standards for School Mathematics* (NCTM 2000). The mathematics lesson is based on content that all students should know and be able to do. The assessment process and information enhance student learning. Students are equitably assessed because the focus is on their individual learning. Because the learning targets, expectations, and criteria are published, the process is open. The inferences drawn from the gathered evidence are valid because students have multiple opportunities to demonstrate their knowledge and skill. The assessment is coherent since it is aligned with curriculum and instruction. Students assume responsibility for their own learning. They know the learning target. They engage in the task and record their understandings. They determine their own level of achievement using the rubric. The responsibility for learning is distributed between student and teacher.

During student-led conferences, parents review collections of work, read the attached learning objective and description of each task, and review the rubric that defines levels of achievement. This helps parents understand expectations and compare a student's achievement against a standard rather than with a sibling or peer's performance. When parents help students and teachers set goals, they become responsible members of this learning community.

Assessment used in this way is formative and promotes learning. Students understand expectations, keep records, monitor achievement, recognize and communicate progress and achievement. They learn how to learn. They learn how to assign value to their work. They set realistic learning goals. They prepare for summative assessment experiences with confidence. Everyone has a more complete picture of learning growth and development. Assessment is based upon standards and provides guidance for the learning journey.

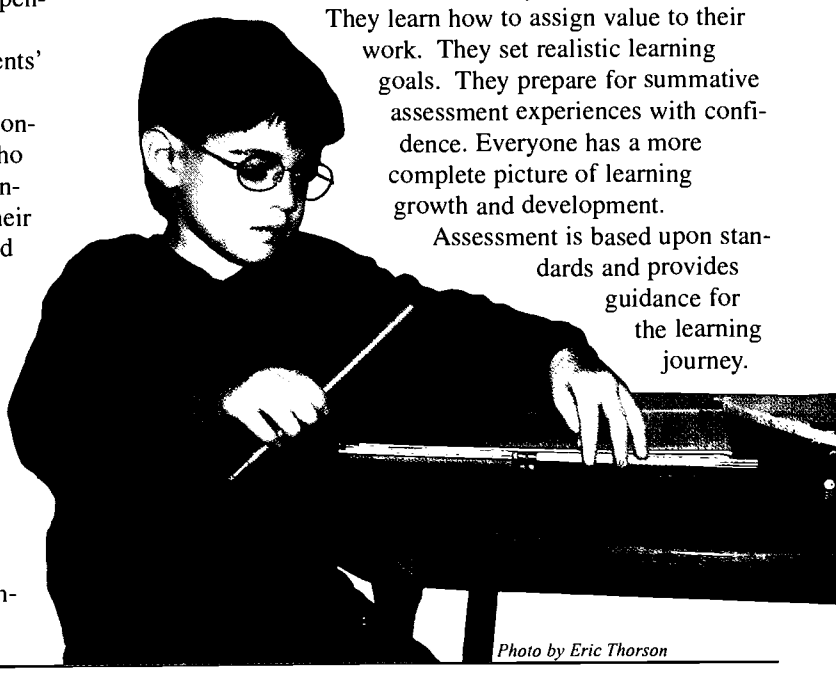

Photo by Eric Thorson

Carol Midgett is a National Board Certified Teacher and Presidential Awardee in Elementary Mathematics who has taught first through eighth grades for 20 years. She served on the NCTM Standards 2000 PreK-2 Writing Team and on the Assessment Addenda Writing Team and participated in the NCTM project to implement the Geometry Standards. Currently, she serves as teacher-on-loan at the University of North Carolina at Wilmington.

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Dovetailing

A thematic unit allowed this teacher to meet three content area standards at once and foster students' creativity, too.

by Louise Stivers, Buchanan Math, Science Magnet Center, Los Angeles, California

When I received the 96-page publication containing the elementary school standards for my Los Angeles, California, school district, I was overwhelmed. How, I asked myself, can I digest this publication, implement the standards, teach my students, and still be recognized by my family at the end of the school year?

Once the mild anxiety attack subsided and I took a closer look at the standards for the second grade, I was not only relieved but excited. Here, at last, was a blueprint for the concepts and skills that I was expected to present to my students. It was also a means of assuring that our expectations for students in California would be equal to those for students in the rest of the nation.

Looking closely at the math and science standards, I saw that they dovetailed under thematic units. For example, both standards called for using and understanding bar graphs. These standards could be linked to a language arts standard calling for students to interpret information from diagrams, charts, and graphs. Standards from the three content areas reinforced each other:

Language Arts—
Interpret information from diagrams, charts, and graphs.

Mathematics—
Students collect numerical data and record, organize, display, and interpret the data on bar graphs and other representations. Measure the length of an object to the nearest inch and/or centimeter.

Science—
Write or draw descriptions of a sequence of steps, events, and observations.

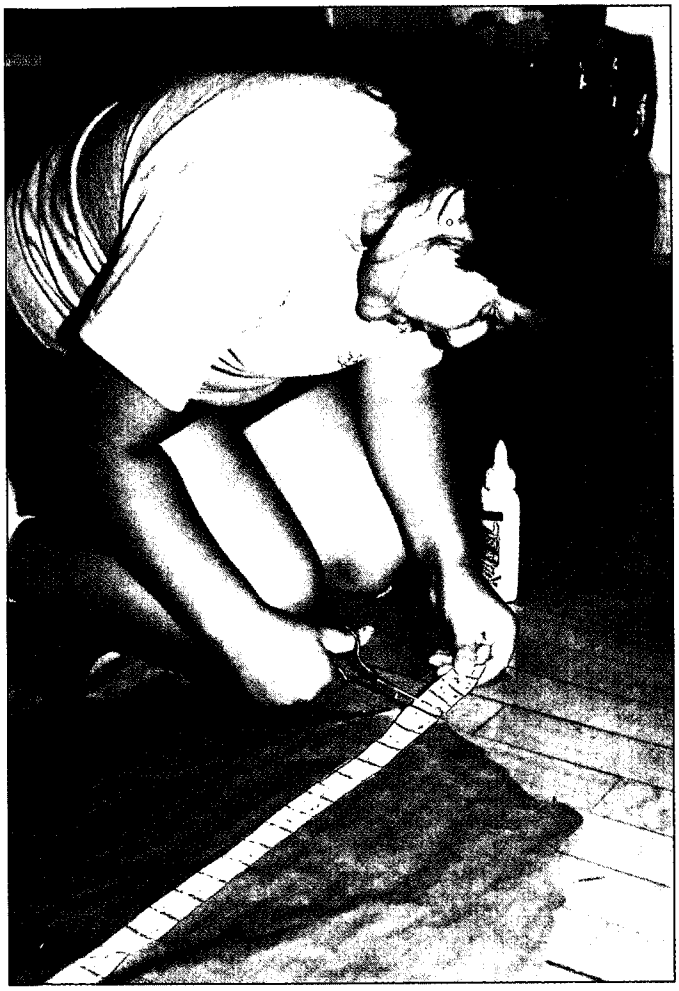
Construct bar graphs to record data using appropriately labeled axes.

Life: There is variation among individuals of one kind within a population.

—From the Interim Elementary Course of Study, Los Angeles Unified School District, Publication No. EC64

After painting his self-portrait, Billy felt sure his parents could easily find his desk on Back-to-School Night.

Standards



Second-grader Rosa made a measuring tape from a strip of one-inch grid paper. She glued the "tape" on the back of her life-size cutout.

For this unit, I decided to have the children graph their different heights to demonstrate variation within a population.

To introduce the unit, we read the picture books *All the Colors of the Earth* by Sheila Hamanaka and *Verdi* by Jannel Cannon. From the math program used in our district, I chose a section on making classroom graphs of favorite foods. This activity gave the second graders a general overview of graphs. For some this activity was a review, but for others it was their first introduction to graphs. The students worked in pairs to collect and record data and compile a bar graph.

To begin collecting the data for our unit, the children lay down on a large sheet of paper. A partner or a parent volunteer traced their full-length outline. Before the children cut out the outline or made measurements, each child painted his or her "portrait." After the paintings were cut out, each child measured his or her height in inches and recorded it on a 3x5 index card. The card was glued on the picture.

Working as teams, the students devised their own method of collecting the data on the class as a whole. Some immediately made a list of names and then recorded the heights. Others started with the heights and matched them to the names of students. Two groups needed help in organizing the data.

The teams presented their findings as bar graphs, using computer programs or grid paper. One team fashioned its graph from snap-on plastic cubes taped to paper.

To finish the unit, the children made one class graph with each child entering his or her own height on a bar graph. They also wrote entries in their journals, describing the steps taken to complete the task, observations they made along the way, and a suggestion for other information we could present in graph form.

Finally, we displayed the portraits and the graphs at Back-to-School Night. Parents were asked to locate their child's desk by recognizing the life-size cutout seated there.

Louise Stivers is a National Board Certified teacher at Buchanan Math, Science Magnet Center in Los Angeles, California. She is a member of the National Science Teachers Association and the California Science Teachers Association.

Photos by Louise Stivers

Technology Can Help You Meet the Standards

This veteran teacher believes that her colleagues "need to hear more first-hand stories from other teachers that technology in the classroom is worth their time investment."

by Jaclyn Snyder, Langley High School, Pittsburgh, Pennsylvania.

Today's emphasis on educational standards may be easing the minds of those in political office and in America's living rooms, but it's daunting to many teachers. One major reason is that many of us lack the instructional tools necessary to meet those standards.

Often, when a new curriculum is introduced, we teachers are excited that the changes will help students meet tougher challenges. But frequently the changes are superficial, reflecting politically correct goals rather than true reforms that will affect a student's ability to grasp the knowledge.

Expert Panel Designates Exemplary & Promising Programs

The Math and Science Education Expert Panel of the U.S. Department of Education published the report *Exemplary & Promising Mathematics Programs* in 1999. In addition to the Cognitive Tutor Algebra program described in this article, four other mathematics programs were designated as Exemplary: College Preparatory Mathematics, Connected Mathematics, Core-Plus Mathematics Project, and Interactive Mathematics Program.

In the 1999 report, five programs were designated as Promising: Everyday Mathematics, MathLand, Middle-school Mathematics through Applications Project, Number Power, and The University of Chicago School Mathematics Project. In 2000, two more programs were designated as Promising: I CAN Learn and Growing with Mathematics.

An online version of the 1999 report is available on ENC Online (enc.org/professional/federalresources/exemplary). For copies of the print publication call (877) 433-7827. For more information about the Expert Panel System, visit the web site (www.ed.gov/offices/OERI/ORAD/KAD/expert_panel/index.html) or call (800) 258-0802.

See the electronic version of this magazine (enc.org/focus/standards) for direct links to the U.S. Department of Education reports on Exemplary and Promising mathematics programs.

Change Is the Child of Frustration

I have taught mathematics at Langley High School, an urban school in Pittsburgh, for 26 years. For quite some time, my colleagues and I were completely frustrated by the lack of student achievement in math.

We were jaded by new textbook adoptions because we had been let down in the past. For example, our district adopted a textbook that claimed to meet new standards. Close inspection revealed that very few meaningful alterations had been made to the previous version of the text. Not long after we began using it, a report from the American Association for the Advancement of Science (AAAS; www.project2061.org/newsinfo/research/textbook/index.htm) was released, rating textbooks in terms of their effect on student learning. Our book was ranked the lowest.

Based on experiences like this, we were motivated to take any possible measure to help kids learn. We were ready to accept the significant challenge of implementing a computer-based curriculum in our classes. To be sure, standards in Pennsylvania require that students use technology and computers, but in all the city schools I had visited, computer labs were mostly used by English composition classes for word processing purposes. Using computers as a major component of the mathematics curriculum was uncharted terrain.

Change Takes Time

Our first step was applying for a grant from Apple to obtain a computer lab. Receiving the grant was one of the best things that could have happened to us. Soon after our lab was in place, Carnegie Mellon University became interested in working with us on a new program that they were developing. The curriculum was based on the findings of cognitive science and used computers as a major component of the instruction.

Our principal should be commended for allowing us to collaborate with the university. He knew that our traditional approach to math instruction wasn't working, and so he gave us time to prove that this approach would.

We made many strides the first year, but we still had a long way to go. We faced several challenges in creating problems that would feel relevant to students—and relied on student feedback as the curriculum was developed. Forget about the two trains on a path for collision in the dark, students told us. They wanted problems that dealt with real-life issues that they might face in the working world.

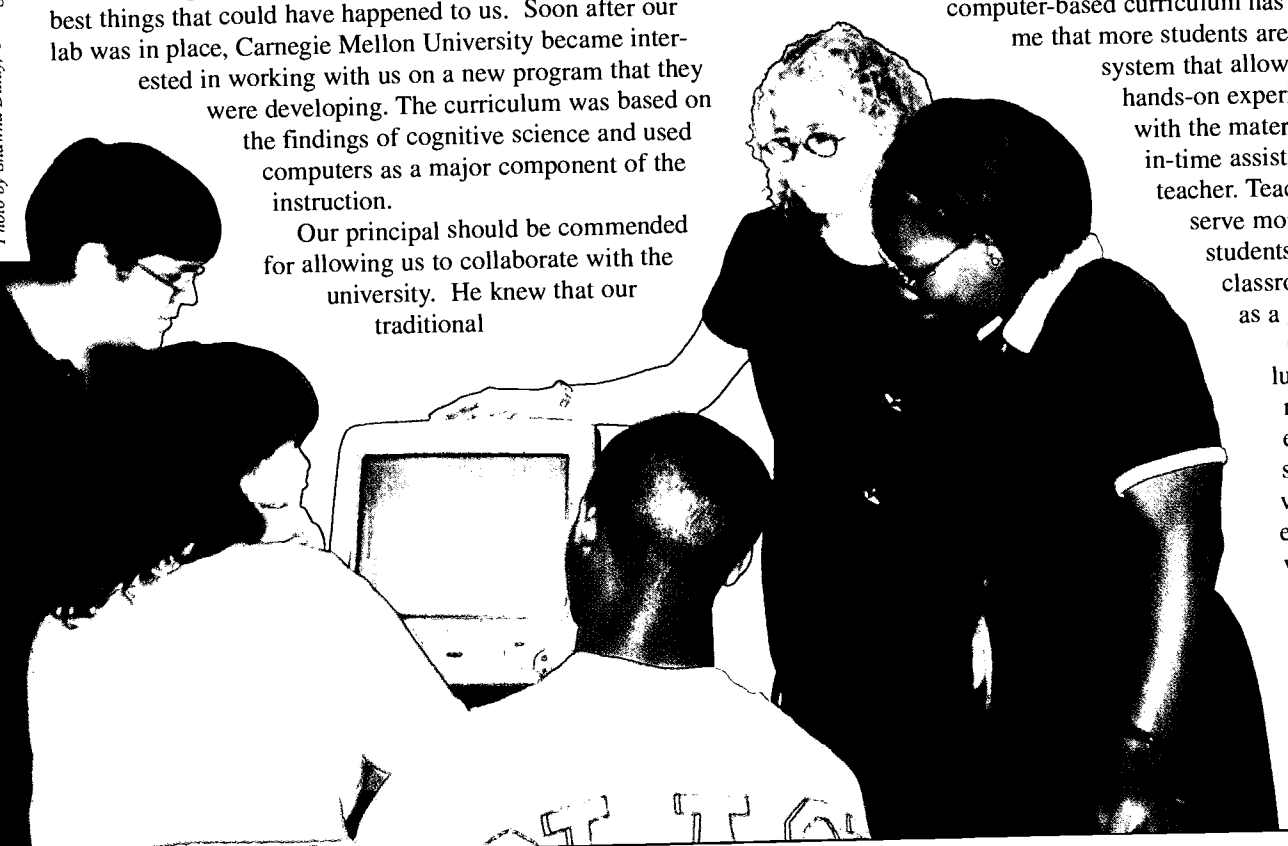
Meanwhile, the Carnegie Mellon researchers tweaked the software. Along the way, they discovered that they needed a fresh approach to help high school students struggling to learn algebra. These students didn't need bells and whistles, but they did need the occasional onscreen help window and the addition of a feature that gave them continuous assessment and feedback on their progress.

Change Takes Flexibility

As the software became more useful for the students, many of us teachers needed to overcome our urge to be the "sage on the stage." Slowly, I found myself adapting to the role of "guide on the side." My students were learning by doing with the computers, and I needed to step back and let them make their own connections, solidifying new knowledge in their minds through the process of putting that knowledge into practice.

The transition from sage to guide can be very difficult for a teacher who has mastered a powerful style that works well with certain students. But my experience with the computer-based curriculum has convinced me that more students are reached by a system that allows them hands-on experimentation with the material and just-in-time assistance from the teacher. Teachers better serve more of the students in each classroom by acting as a guide.

Our curriculum also requires teachers to allow students to work at different levels. I was pleased to find that many of my students begged to



work ahead. Their enthusiasm, however, put certain demands on me to adapt to each individual student's needs, based on his or her progress in the curriculum. Although it was somewhat demanding to switch gears from student to student, I believe it allowed all of our students a better chance at achievement—and was therefore worth that extra effort.

Of course, one reason the teachers at Langley were open to change is that we were not simply being trained to use a new program. Our participation in developing the program was possible because the curriculum developers and our school administrators were receptive to our suggestions for optimizing the program, allowing its full integration into our classrooms. We knew immediately what was working and what wasn't from the feedback and the results we were getting from our students. We experienced a sense of pride and ownership from the experience of shaping a curriculum as we used it.

An Exemplary Program

Our years of curriculum development and classroom research led to the creation of the Cognitive Tutor for Algebra, Geometry, and Algebra II, published by Carnegie Learning. Cognitive Tutor Algebra was recently recognized by the U.S. Department of Education as one of five Exemplary mathematics programs. (See box on page 40).

Like many other curricula on the market, Cognitive Tutor is standards-based. But the approach is different. We believe this difference is the reason for its success. Use of computers is not the only factor because problems are presented on computers about 40 percent of the time, and the rest of student time is spent using the textbook in a classroom without computers.

Whether students are working on or off the computers, we have found that learning happens when students are involved all along the way. To keep them involved, the mathematics problems must differ from those found in traditional curricula. Cognitive Tutor uses real-world problems that students will encounter in the work place.

For example, instead of telling students that they need to master $3x + 6 < 5x - 4$, we ask students to solve the following problem:

A few students started their own companies selling similar handmade friendship bracelets. Molly's company sells the bracelets for $3 each with a shipping charge of $6 per order. Lily and Emma's company charges $5 for each bracelet (no shipping charge) with a one-time rebate of $4. What is the minimum number of bracelets you need to order so that Molly's company offers the best price?

With problems like these, either from the computer or textbook, students come to understand that algebra may be an abstract tool but it is one that can be useful in many different contexts.

Of course, time spent on the computer does increase student learning in that they can work at their own speed, as previously mentioned. Over time, we made some decisions about the best way for the computer program to interact with students. For example, if a problem becomes insurmountable, the computer does not give away the answer, but the student knows that he or she can ask for help from the teacher. Student involvement is enhanced by the onscreen skill-o-meter, which lets students know how close they have come to meeting course goals. That way they are in charge of assessing their own progress.

The Payoff: Student Learning

Controlled studies by Carnegie Mellon University researchers have shown impressive results in students using Cognitive Tutor as compared with students in traditionally taught classrooms. The studies have found:

- An average improvement of 227 percent in students' problem solving abilities;
- Twice the likelihood that students will complete higher level courses in mathematics like Geometry and Algebra II;
- 50 percent less time required for teachers to review material (because of better retention);
- Gains of 15-30 percent on standardized tests such as the SATs, the Iowa achievement tests, and TIMSS.

Most impressive for Langley High School has been the elimination of all lower-level general math courses. Algebra I is the lowest level math class we offer at Langley; before this program was instituted, we had half a dozen classes below Algebra I.

The stakes are higher than ever. If our students at Langley and throughout the city of Pittsburgh don't pass algebra, they will not receive a high school diploma. Instead they'll earn a "certificate of attendance." Traditional curricula did not help us reach all of our students or meet tougher standards. So we are taking steps to bring new curricula and new approaches to the classroom. Each step we take is part of the learning process—and each step brings us closer to success for all students.

Jackie Snyder has taught mathematics at Langley High School for 26 years, serving as mathematics department chairperson for 18 years. She has been active in the New Standards Project at the University of Pittsburgh and has worked for almost five years on Carnegie Learning's Cognitive Tutor research with Carnegie Mellon University. She can be reached at geometryrules@aol.com

High Standards for All—

A Key Ingredient of Systemic Reform

Educational equity must be at the forefront in the standards-based classroom.

by Aleta You, New Jersey Statewide Systemic Initiative, Rutgers, the State University of New Jersey

It's a hard truth: opportunities to participate in high-quality educational programs in mathematics, science, and technology have not been equally available to all students. Certain ethnic and racial minorities, including populations of students from economically disadvantaged backgrounds, are substantially underrepresented among top achievers and are included in disproportionate numbers among those whose achievement is unsatisfactory.

Systemic reform in mathematics, science, and technology education is based on the premise that all students—regardless of their race/ethnicity, gender, national origin/culture, English speaking proficiency, ability/disability, and socioeconomic class—must be given opportunities to acquire strong mathematical, scientific, and technological skills.

What can a school system, especially its teachers, do to move toward high standards for all students?

Equity Indicators

The suggested indicators are designed to assist educators in determining if educational equity in their own districts meets national standards.

Curriculum, Instruction, and Assessment

- ❑ Are teachers implementing standards-based mathematics and science instructional programs in all their classes?
- ❑ Do teachers use real-world problems to connect mathematics, science, and technology to students' lives?
- ❑ Are teachers receiving high quality professional development in standards-based mathematics, science, and technology programs?
- ❑ Are teachers given sufficient resources and equipment to implement hands-on and inquiry-based mathematics, science, and technology in their classes?
- ❑ Are curriculum materials in mathematics, science, and technology education bias free? Does the classroom have posters or pictures that reflect the contributions that people of color have made to mathematics, science, and technology?
- ❑ Are all students actively engaged in cooperative learning teams that are heterogeneously mixed? Is there individual accountability for group activities?
- ❑ Are alternative assessment strategies, such as portfolios, oral reports, group presentations, paper and pencil tests, used to assess student achievement in mathematics, science, and technology?
- ❑ Do teachers receive professional development in multiple learning styles, teacher expectations, teacher/student interaction, and diversity?
- ❑ Do guidance counselors receive professional development on expectations, equity, and career development in encouraging all students to consider careers in mathematics, science, and technology? In what specific ways do counselors reach out to underrepresented groups of students to encourage them to pursue high quality courses and careers in mathematics, science, and technology?

District Policies and Practices

- ❑ What are the district's policies on tracking and grouping students in mathematics, science, and technology courses?
- ❑ Does the district collect disaggregated baseline data by gender and ethnicity?
- ❑ Are some groups placed in lesser numbers in high-level classes or in greater numbers in low-level classes than their percentage of the total student population would suggest?
- ❑ Does the district analyze the data that it collects to identify if there are areas of substantial differentials between high-achieving groups and underrepresented groups in the district?
- ❑ If differentials exist, is the district developing benchmarks, outcomes, and strategies to deal with differences between high-achieving groups and underrepresented groups in the district?
- ❑ Are the requirements in mathematics, science, and technology applicable to all students or do they vary for different populations of students?
- ❑ What criteria are used for students to enroll in gifted and talented classes and advanced mathematics, science, and technology courses? Is there an underrepresentation of poor and minority students in these classes?
- ❑ What are the district's referral and classification practices for special education? Is there a disproportionate number of poor and minority students enrolled or classified in special education?
- ❑ What are the district's practices regarding language-minority children? Are there sufficient support systems in place to assist these children in achieving at their grade level?
- ❑ What criteria does the district use to enroll students in basic skills and compensatory education? Are there supplemental programs such as tutoring, summer institutes, and other support mechanisms to raise the achievement level of these students?

Community Outreach

- ❑ Are parents involved in programs such as Family Math, Family Science, Family Tools and Technology (FT2), and Families Achieving the New Standards (FANS)?
- ❑ Do parents serve as role models or guest speakers to talk to students about their occupations and their use of mathematics, science, or technology in their careers?
- ❑ Have community outreach programs been developed to educate parents about the kinds of mathematics, science, and technology courses and programs that are available and the importance of having their children enroll in these courses and programs?
- ❑ Are business, industry, and community organizations involved in mathematics, science, and technology reform?

The list of Equity Indicators in the box on page 43 will help educators begin to answer that question. The Indicators were developed for the New Jersey Statewide Systemic Initiative (NJ SSI) to reform mathematics, science, and technology education in New Jersey's schools. While the list is not exhaustive, it is designed to help educators improve equity in their schools by examining curriculum, instruction, and assessment; administrative policies and practices; and community outreach within their districts.

Equity is Essential

In the past, educational equity was regarded as a separate entity. Today, educators can no longer regard equity as an add-on to an educational program; it must be a critical component in the reform of mathematics, science, and technology education for all children (Campbell & Kreinberg, 1998).

The National Council of Teachers of Mathematics (NCTM, 1989 & 2000) the *National Science Education Standards* (NRC, 1996), *Project 2061 Science For All Americans* (AAAS, 1990), and *Benchmarks For Science Literacy* (AAAS, 1993) articulate the need for equity to be at the forefront of school reform in mathematics, science, and technology education.

In *Infusing Equity in Systemic Reform: An Implementation Scheme* (1998), the National Science Foundation states that equity cannot be an isolated concern but is to be "an essential and inherent component of high-quality mathematics and science at all levels of education" (p. 6).

Equal Is Not Necessarily Equitable

Patricia Campbell and Nancy Kreinberg (1998) argue that equal treatment for all students does not necessarily lead to high-quality instruction in mathematics and science. Children have multiple learning styles and may require different instructional strategies to be successful in standards-based mathematics and science education. However, the diversity of children's needs "cannot be used as an excuse to track students in or out of advanced mathematics and science" (p.2).

Not all children will achieve at the same level, but in an equitable school, "differences in achievement will not be based on race/ethnicity, gender, or physical disability. If students' achievement can be predicted by their gender, race, ethnicity, or physical ability, then the system is inequitable and must be changed" (Campbell & Kreinberg, 1998, p. 2).

The collection of disaggregated data (that which couples achievement data with students' gender, ethnicity, and course enrollment) serves as a tool to identify problems and assess various solutions. When this occurs, everyone is held accountable.

Reasons for the Achievement Gap

In *Thoughts and Deed—Equity in Mathematics and Science Education,* Stephanie Robinson cites three factors contributing to the increasing achievement gap of poor and minority students (Kreinberg and Wahl, 1997):

- Low expectations. Students in high-poverty schools are assigned good grades for low-level academic work.
- Curricular tracking. There is a greater tendency, regardless of potential and aptitude, for poor and minority students to be placed in special education and low-track classes than in high-level and advanced placement classes.
- Inadequate fiscal and human resources. Forty percent of high school mathematics courses in high-poverty schools are taught by teachers who lack the minimum coursework to complete even a minor in mathematics.

These factors can only be addressed through systemic reform that is designed to bring about comprehensive and coordinated changes that are sustained over time.

Measuring Progress

Jane Butler Kahle (1998) suggests that one way of measuring progress toward achieving equity in science and mathematics education is to develop an "equity metric." Key indicators that a system is becoming more equitable may include the following:

- Retention and achievement in eighth-grade algebra are high.
- Quality and content of science and mathematics courses are improving.
- Data obtained from achievement tests reflect a narrowing of gaps and increased achievement by all subgroups of students.
- Evidence shows that teaching practices are becoming more inquiry based and are actively involving students in the learning process (p. 5).

Improving the outcomes for all students in mathematics, science, and technology is not an easy task. Bandage approaches to educational reform do not work. As a nation, we cannot afford an educational system in which students are ill prepared to meet the challenges that are needed for an educated and highly technological work force.

As the demographics of our country continue to change, it is incumbent upon us to provide a high-quality mathematics, science, and technology education for all children.

To do otherwise would condone a system of disposable children who are unprepared to take advantage of the social, economic, political, and educational opportunities in the twenty-first century.

Aleta You currently serves as the Senior Equity Specialist for the New Jersey Statewide Systemic Initiative (NJ SSI) at Rutgers, The State University of New Jersey. She was the former editor of the U.S. Department of Education Dwight D. Eisenhower National Mathematics and Science Education Newsletter and Project Director for Science Teams at Rutgers University. She can be reached via email (aleta@dimacs.rutgers.edu) or by phone at (732) 445-2438.

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Kahle, J.B. (1998, August). *Measuring Progress Toward Equity in Science and Mathematics Education*. Washington D.C.: National Institute for Science Education, 2, 1-7.

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Equity Web Sites

AAAS Collaboration for Equity–American Association for the Advancement of Science

ehrweb.aaas.org/ehr/3_2_0.html

This project works toward fairness for girls and women in science and mathematics education.

American Association of University Women

www.aauw.org

This national organization promotes education and equity for women.

Center for Family Involvement in Schools—Rutgers, The State University of New Jersey

www.rci.rutgers.edu/~cfis

The Center provides equity-focused professional development programs and resources (including Family Math and Family Science) that strengthen family-school-community partnerships and support the academic, intellectual, and social development of all children.

EQUALS–Lawrence Hall of Science, University of California at Berkeley

equals.lhs.berkeley.edu

EQUALS programs work to increase access and equity in mathematics for all students, particularly underrepresented groups.

EQUITY 2000— The College Board

www.collegeboard.org

This research-based K-12 education reform program was established to enhance minority preparation for, and success in, higher education and the world of work.

FANS—Rutgers, The State University of New Jersey

dimacs.rutgers.edu/fans

FANS stands for "Families Achieving the New Standards" in mathematics, science, and technology education. The site provides workshops to inform parents about the mathematics, science, and technology standards, to involve parents in helping children reach the standards, and to encourage parents to support the local implementation of standards.

Quality Education for Minorities (QEM) Network

qemnetwork.qem.org

The QEM Network provides technical assistance on mathematics and science-related issues to educators.

Women's College Coalition

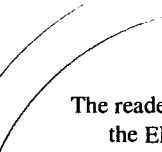
www.academic.org

The Coalition provides information to parents and teachers about role models, ways to support mathematics and science in the home, and resources about programs for girls.

WEEA Equity Resource Center

www.edc.org/WomensEquity

The national WEEA (Women's Educational Equity Act) Equity Resource Center works with schools, community organizations, businesses, and individuals to publish and disseminate resources for multicultural, gender-fair education.



The reader is encouraged to visit the ENC equity web site Making Schools Work for Every Child (equity.enc.org) to link to an extensive list of equity web sites and resources. As always, links to all web sites mentioned are provided in the electronic version of this magazine: enc.org/focus/standards

A Safe Environment for Creating a Standards-Based Classroom

This professional developer describes one district's long-term commitment to helping teachers meet new mandates.

by Sandra E. Fluck, Moravian College, Bethlehem, Pennsylvania

As a teacher, I value a safe learning environment. I want a place where I can talk about my ideas and access the tools I need without someone rushing me, ordering me around, appearing displeased, or making fun of my thinking. I believe most adults would agree with my definition. The reality is, children want the same thing. Children want to feel safe while they are learning.

What does this have to do with creating a standards-based classroom? Everything. If students do not feel safe enough to express themselves, they cannot engage in the dialogue that is crucial to standards-based teaching. For some teachers, the prospect of students feeling free to express their ideas is threatening. They fear that they will lose control or not know the answer to every question that arises.

This type of anxiety is often acutely felt by elementary school teachers when they are teaching math and science. Elementary school teachers are expected to teach everything. This is an awesome task and should not be taken lightly. However, most education courses for the elementary grades stress reading and language arts instruction more than mathematics and science. As a result, elementary school teachers often must rely on school district-sponsored inservice programs to keep up with research and curriculum developments. Secondary teachers generally can keep abreast of their field by joining the national organization devoted to their specialty. Elementary teachers would have to join several national organizations and would never be able to keep up with all the literature. All of these difficulties can be addressed through professional development.

One-day workshops can be helpful, but the long-term benefits are not evident.

A Long-Term Commitment to Professional Development

Quality staff development requires resources and a long-term commitment from the school district. One-day workshops can be helpful, but their lasting benefits are not evident. During the 1999-2000 school year, I began working with Rose Tree Media School District in Media, Pennsylvania, a suburban district outside Philadelphia that was willing to make a long-term commitment.

Two years earlier, I had given several one-day workshops in the district. The teachers had implemented a basal mathematics program, but curriculum leaders wanted a more constructivist approach to teaching mathematics. The constructivist approach, which builds on the child's knowledge, is in line with the National Council of Teachers of Mathematics (NCTM) *Principles and Standards for School Mathematics* (2000). The district was committed to moving forward, to helping their teachers make those standards come to life in their classrooms.

Fall Planning

In the fall I met with the administrative team to discuss changes in mathematics instruction. We decided to develop leadership skills within the teachers' ranks during the first year. Principals in each of the district's four elementary buildings established a grade-level team for the mathematics project. In one building, the team included one kindergarten teacher and three first-grade teachers. The other buildings had teams made up of second-, third-, or fourth-grade teachers. The goal was to establish a team of teacher leaders at each grade level. Fifth-grade teachers came on board later.

In early December, the four teams of teachers, the district administrators, and I spent a day off campus in a local restaurant with meeting rooms. Our kick-off day began with breakfast and remarks from key administrators. I began by introducing the teachers to a constructivist approach to teaching mathematics. We had purchased materials that were constructivist in nature, teacher-friendly, and easily integrated into the district's basal mathematics program. I spent the rest of the day engaging the teachers in hands-on activities appropriate for kindergarten through fourth-grade classrooms. We talked about the mathematics included in the activities and the solid pedagogy in this approach to teaching. At the end of the day, we discussed our plans for the rest of the school year.

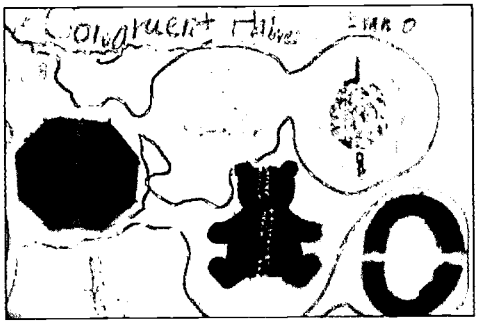
January to May

Between January and May, I spent four half-days with each teacher team. During the first meeting with each team, we selected a mathematics unit to focus on during that year. At the close of the first meeting, each team decided what they wanted me to do at the next meeting. Each team had different needs. I had the freedom to accommodate these needs.

During my other three half-days with each team, many different things happened. One team spent its time planning the unit. We talked about every activity and how it related to the rest of the curriculum. We prepared teaching materials and developed an organizational chart to keep the teachers on track as they taught the unit.

The other three teams wanted me to do demonstration lessons in their classrooms. The teachers enjoyed watching me, but more important, they enjoyed watching their students react to the activities. Sometimes they were amazed at how much their students knew or how quickly the students caught on to the ideas presented.

I was particularly struck by one teacher's comment. She said that my approach to teaching would be "good once a week," but she could not see how my approach would "cover the curriculum." At first I felt offended that she thought the constructivist approach was merely fun and games. However, I did not have to come to my own defense. The other teachers did. They started talking about the mathematics that was evident in the activities. They talked about how engaged the students were and how even those who usually do not participate were involved. I realized that the teacher who criticized constructivist methods really feared she could not do what I had demonstrated.



The beauty of standards-based classrooms is: None of us has to follow a formula.

The beauty of standards-based classrooms is: None of us has to follow a formula. However, one thing we do need to do is become secure in our content background as well as our dedication to good teaching methods.

Sometimes when the teachers and I were discussing activities in their units, the teachers had questions about the mathematics content. This gave me an opportunity to discuss mathematical concepts, and the teachers were always quick to grasp the mathematics. They just needed some guidance and some time to ask their questions in a safe place. As an outsider to the district, I could easily create that safe place. For the rest of the year, whatever our tasks were on our half-days together, we always took time to talk and reflect about mathematics content.

Spring Culmination

We ended the first year with another full-day meeting away from the school campus. Each teacher team was scheduled to give a 45-minute presentation of the unit they had taught with their students. The teachers knew this from the beginning and had been preparing for it all semester. They saved samples of student work, took photographs, and gathered materials. All these items illustrated a standards-based classroom setting.

As I looked around the large meeting room, it was obvious which team was at which table. One table was piled high with stuff. The kindergarten/first-grade team had brought boxes of materials. The other teams brought supplies as well, but one team managed to get all its supplies in one box. Again, this was a demonstration of the different approaches among the teachers.

The Following Fall

At the beginning of the fall term, the team leaders repeated their May presentations for their colleagues in other schools. Although I attended the presentations, the responsibility for demonstrations was now on the team leaders.

The school district continued to support the teachers in this new model of staff development as we moved into the 2000-2001 school year. Another four half-days for each grade-level team to work with me was established. Only now our work involved two teams per building.

Throughout the school year, I continued to spend time with the established grade-level teams and the newly formed teams. In time, there will be a primary and an intermediate teacher team in each of the elementary schools. The district provides substitute teachers so that the first-year and the second-year teams can continue their work with me and with each other. We will continue to talk about mathematics and pedagogy.

As we look to methods for improving teaching and creating standards-based classrooms, this model has much merit. I think of it as on-the-job training. One-day workshops give us a boost, but on-the-job training has a far more lasting effect. The 16 teachers in the original group have become instructional leaders and mentors for another 16. Together they can make standards-based teaching the norm, not the exception, in their school district.

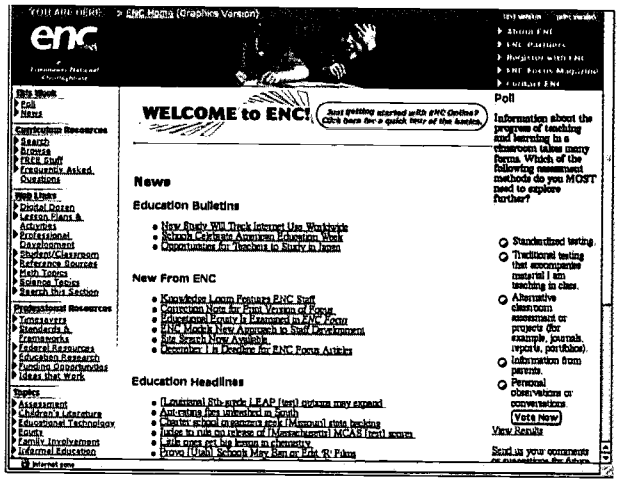
Sandra E. Fluck chairs the education department of Moravian College, in Bethlehem, Pennsylvania, and has spent the last 10 years working with both preservice teachers and certified teachers in the field. During the summer, she facilitates weeklong mathematics education workshops for elementary teachers.

Reference

National Council of Teachers of Mathematics, (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

Visit ENC's Web Site enc.org

ENC Online is designed to make the resources of the Eisenhower National Clearinghouse available to educators everywhere all the time. Here is a quick introduction to the site. We urge you to "jump online" and discover for yourself how helpful enc.org can be to you.



Curriculum Resources. In this area of the site, you can use a simple or advanced search to locate all types of teaching materials in ENC's collection of more than 18,000 items. The searches allow you to choose particular subject words, grade level, cost, and type of material to find exactly what you need for your classroom situation.

Web Links. Check this category for ENC's popular Digital Dozen feature. This monthly selection of exemplary math and science web sites can also be delivered to your email box if you choose to register. Web Links also connects to hundreds of sites with math and science lesson plans. A search feature helps you find Internet resources quickly and efficiently.

Professional Resources. This portion of the site is designed as a teachers' professional support system. ENC has gathered some of the most popular professional resources in one Timesavers area for quick linking and use. This section also provides links to the national mathematics and science education standards, and state frameworks are listed conveniently by state. Federally funded resources and professional development strategies are also available here.

Topics. Hundreds of articles, teacher interviews, and selected curriculum resources and web sites are arranged thematically in this area. Topics include inquiry and problem solving, educational technology, equity, and assessment. Many of these topics include the content developed for *ENC Focus*.

ENC Online also has a quick way to get to the full text of each issue of *ENC Focus*—try the ENC Focus Magazine area of the web site. In this area, you can also sign up for a free subscription to all future issues of the print magazine.

Destination: Standards

Teachers need good reasons to change their practice. This school principal describes sources of data that will help unify schools as they work to meet new standards.

by Keith C. Rittel, Anacortes High School, Anacortes, Washington

It could well be argued that the very existence of national, state, and district standards (often connected with standards-based examinations) should motivate school administrators and teachers to make whatever changes are needed to bring their schools into alignment. However, with countless pressures coming from every direction, it is certainly understandable why many school-based educators do not readily respond to such external edicts. As a school principal, I feel it is my role to help make the case for change by supplying teachers with meaningful data from a wide variety of credible sources.

I have found that teachers are looking for relevant information that provides legitimate reasons for them to make changes in their classroom practice. Figure 1 lists some of the sources of data that I have provided to teachers in my school. We have found that when we make the comparisons listed on the chart, we have a picture of where we are and where we need to go.

Another valuable school-based data source is grades. We have found that grades earned by students—especially F grades—provide interesting insights, especially when they are analyzed by subject area, by grade level of students, by teachers, and by other factors, depending on the school. F grades among ninth-grade students are important to track from year to year as we consider the transition to high school.

Effective Use of Data

Unfortunately, data such as that listed in Figure 1 are sometimes used to place blame or to pressure people to change. Those who share data must be without guile or malice, remembering that negative tactics rarely result in positive change. Data are better used to demonstrate trends and to generate questions from which we can draw some additional questions and/or conclusions.

To use data in a meaningful way, we must always be certain that we understand where the information came from.

First and foremost, the sources for the data must be cited, but regardless of the source, we also must ask what questions were asked in gathering the data and whether the data were gathered in a defensible fashion. *How to Lie with Statistics* by Darrell Huff is an excellent source of help for answering these kinds of questions.

We have all heard politicians stretch data or conveniently ignore certain pieces of information to make a case. Certainly, it is much more convincing to include contradictory data. This kind of openness helps generate appropriate questions, and it demonstrates the determination to find the truth. The very need for change falls under a shadow of doubt if it is supported by one-sided data.

Teachers are educated, thoughtful people. As principal, I believe I can and should provide guidance, but I also listen to teachers as they draw conclusions and generate questions. As we share our concerns, we as a school faculty become unified in purpose. We all want to be part of an effective solution once we agree there is a need for improvement.

Solutions Based in Best Practice and Research

Most educators want practical ideas we can apply to our own classrooms. We also want to be allowed to use our own creativity to solve problems, but we usually do not have time to generate all of the best solutions for every issue.

Sources for ideas include schools that are accomplishing the changes we are considering. However, we must remember that every school is a complex system, and some programs may not be replicable in other settings.

Educational research published in books and professional journals can be invaluable resources as well. Journals published by professional organizations also provide a wealth of useful ideas from practitioners. At the end of this article is a list of a few of the most significant publications I have used in my own situation.

There are many more critical dimensions—staff development, district/board support and involvement, funding, time, curriculum revisions, and so on—to creating positive change in schools. Nevertheless, meeting the standards seems to be comprised of two essential elements. The first is the concept of actually moving, changing, improving. The second element is the standards themselves. I submit that if we look at relevant and meaningful data, we will establish the impetus needed for movement. Once we are moving in the right direction at a reasonable pace, the standards will become the destination.

Our task is not easy, but it is the right thing to do. We need to get our schools moving, and all of us have an important role in the process.

Keith C. Rittel is in his fourth year as principal of Anacortes High School in Anacortes, Washington. He has compiled a comprehensive profile of his school based on many data sources—some of which are recommended in this article—and is working with his faculty in moving toward the new standards in Washington State and in education generally. Contact him via email (Krittel@asd103.org).

Data Source	Multiple Years	Compared to National	Compared to State	Compared to Region	Compared by SES*
Content-based tests ("Iowa" tests, etc.)	Yes	Yes	Yes	Possible	Yes
Process-based tests (State Standards tests)	Yes, where applicable	Probably not applicable	Yes	Yes	Yes
SAT and ACT Scores	Yes	Yes	Yes	Possible	Possible
Drop-out rates	Yes	Yes	Yes	Possible	Possible
Graduation rates	Yes	Yes	Yes	Possible	Possible
Surveys (such as the ACT, others)	Depends on survey	Depends on survey	Depends on survey	Depends on survey	Depends on survey

*Figure 1. Data that Make the Case for Classroom Change (*SES = Socioeconomic status)*

Suggested Reading

Barth, R. S. (1990). *Improving Schools from Within*. San Francisco, CA: Jossey-Bass.

Fraenkel, J. R., Wallen, N. E. (1993). *How to Design and Evaluate Research in Education* (Second Edition). New York, NY: McGraw-Hill.

Huff, D. (1954/1982). *How to Lie with Statistics*. New York, NY: Norton

National Association of Secondary School Principals. (1996). *Breaking Ranks: Changing an American Institution*. Reston, VA: NASSP Press.

Spady, W. G. (1998). *Paradigm Lost: Reclaiming America's Educational Future*. Arlington, VA: American Association of School Administrators Press.

Zemelman, S., Daniels, H., & Hyde, A. (1998). *Best Practice: New Standards for Teaching and Learning in America's Schools* (Second Edition). Portsmouth, NH: Heinemann.

Focus on the Collection

This section presents highlights from the full ENC record for exemplary resources selected to illustrate this issue's theme.

ENC's Collection and Catalog

ENC's collection of mathematics and science resources is the most comprehensive in the nation. More than 18,000 resources are housed in our national repository, with new items arriving daily. We collect materials from federal and state agencies, commercial publishers, professional organizations, school districts, and individuals. The collection includes print materials, software and CD-ROMs, kits and manipulatives, along with hundreds of excellent Internet sites.

All materials are cataloged by ENC, and the catalog records are searchable from our web site (enc.org). Part of each catalog record is a detailed description of the resource written by ENC experts in mathematics and science education. These descriptions are not evaluative reviews, but the online record does include references to reviews, awards, and other evaluative materials.

A Systemic Approach to Standards-Based Learning

by Carol Damian and Terese Herrera, ENC Instructional Resources

Establishing educational standards in mathematics and science is a way of recommending what all students should know and be able to do by the end of a certain grade level, or upon completing elementary, middle, and high school studies. Whether such standards are national in scope, such as the *National Science Education Standards* (NSES) or *Principles and Standards for School Mathematics* (PSSM), part of a state's framework, or incorporated at the local school district level, they outline a path students can take toward competency in math and science.

In the national standards documents, we see that the process of developing competent students requires the support of the entire educational system. Both PSSM and NSES also agree on the following points:

- Although small gains in achieving improvement can be made by a well-informed, highly effective teacher, implementing standards within any school or classroom requires a systemic approach.
- The "educational system" includes building and district administrators, school boards, support staff, teachers, students, parents, and the community.
- There are improvement and achievement standards for the school system, professional development, student assessment, teaching, education program, and content —all interdependent upon each other.
- Improvement strategies and professional development are to be ongoing parts of standards implementation.
- Recommended instructional strategies for meaningful student learning are inquiry- and problem-solving-based. The student is actively involved in the process of learning, constructing knowledge, and understanding in the content area while learning to learn.
- Standards from K-12 are aligned in such a way that students' learning progresses from the basic and concrete to the more complex and abstract. The standards take into account that students learn at different rates and with a variety of learning styles, intelligences, and interests.

- PSSM and NSES recommend assessment methods that are embedded in instruction and used to drive instruction. Cooperation and collaboration among students and teachers are recommended.

For this Collection Section, we chose the following categories to help you in your efforts to integrate standards into your district's curriculum and your classroom instruction:

What is the vision of the National Standards?

Here you will find the actual NSES and PSSM documents and other items that help explain what they mean to schools.

Implementing the Standards: General Resources

This section houses general guides and suggestions for designing curriculum, disseminating information about the standards, and creating learning communities in the classroom.

Implementing the Standards: Assessment

We think these exemplary resources can help lead educators toward assessment practices that align with instructional methods recommended in PSSM and NSES.

Implementing the Standards: Inquiry and Problem-Solving

To help you meet the awesome task of implementing inquiry and problem-solving instructional strategies into the classroom, we include here a number of resources that help explain inquiry and problem solving, provide case studies for your review, and give concrete "how to" examples.

Implementing the Standards: Integrating Technology

Throughout NSES and PSSM, the case is made for using electronic technology as tools for learning math and science. In this section we provide some resources we hope will help you find ways to best use these modern devices to enhance meaningful learning.

Curriculum Materials: Mathematics and Science

For these two sections we provide, for all K-12 grade levels, examples of instructional materials that are aligned with the national math and science standards. We looked for features such as embedded assessment strategies, active student involvement, real-world applications, and meaningful teacher support.

For Further Reading

As always, when we search for outstanding resources to highlight in our *Focus* magazine, we discover informative, relevant math and science education items that don't quite fit the selected categories. This is perhaps one of our richest sources for self-professional development, teacher study groups, or just keeping up on current ideas and research.

The lists in this section are by no means exhaustive. Due to space limitations, we could not possibly include all of the exemplary resources on the topic of standards-based math and science classrooms that are currently available. You are invited to visit our web site (enc.org) to search the ENC collection for standards-related resources. See page 53 for search tips.

Featured Resources

The Vision of the National Standards

Implementing the Standards: General Resources

Implementing the Standards: Assessment

Implementing the Standards: Inquiry and Problem Solving

Implementing the Standards: Integrating Technology

State Frameworks

Curriculum Materials: Mathematics

Curriculum Materials: Science

For Further Reading

Searching the ENC Collection of Resources

The resource descriptions printed in this magazine are abbreviated versions of the full catalog records available online. You can access ENC's vast collection of curriculum resources by visiting ENC Online (enc.org).

To find the online record for resources featured in *ENC Focus*:

The easiest way to browse the online records of resources featured in an issue of *ENC Focus* is to go to our web site (enc.org) and select the link in the top right corner to ENC Focus Magazine. Select the title of the appropriate issue, then scroll down to the Focus on the Collection section. Finally, follow the links to the records of your choice.

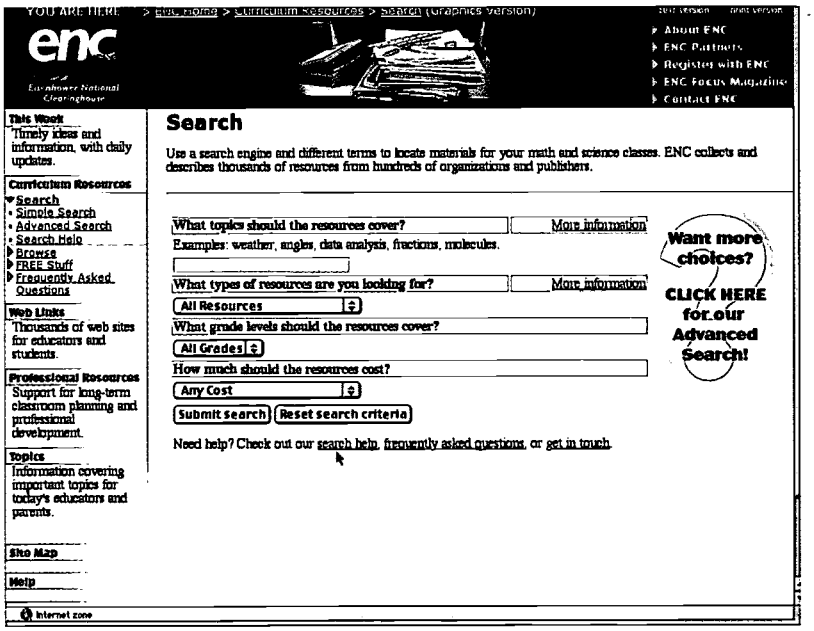
To find other resources:

When you visit ENC Online (enc.org), the Curriculum Resources section in the left navigation bar offers both a simple and an advanced search with help features for each. The advanced search allows you to choose particular subject words, grade level, cost, and type of material to find exactly what you need.

For example, materials for this issue were found through the use of subjects such as standards, frameworks, inquiry, problem solving, and performance-based.

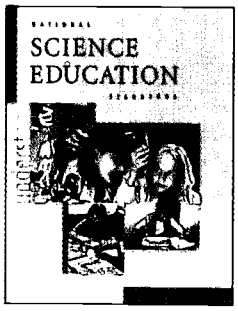
Also in the Curriculum Resources section is the Browse option. Find the subject you are interested in. Once a first page of results is returned, you can use the "Customize using advanced search" feature to further limit your search.

Additional assistance is available online (enc.org/resources/search/help) or by contacting the ENC Information Services staff by email (library@enc.org) or phone (614) 292-9734.



National Science Education Standards

Grades K-12
1996
Author: National Research Council



The *National Science Education Standards* present a vision of a scientifically literate populace. They are guided by the following principles: science is for all students; learning science is an active process; school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science; and improving science education is part of systemic educational reform. The standards describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, and in which supportive educational programs and systems nurture achievement. Topics covered include science teaching, professional development, assessment, science content, science programs, and systems. The document also describes the conditions necessary to achieve the goal of scientific literacy for all students, including opportunities for students to learn and for teachers to teach. The standards for teaching focus on what teachers know and do. The standards for professional development focus on how teachers develop professional knowledge and skill. The science assessment standards are criteria against which to judge the quality of assessment practices and can be used as guides in developing assessment practices and policy. The standards for content define what the scientifically literate person should understand and be able to do after 13 years of schooling. These standards, organized by grade clusters, define content to include inquiry; physical, life, and Earth sciences; connections between science and technology; science in personal and social perspectives; the history and nature of science; and unifying concepts and processes. The program standards, which provide criteria for judging the quality of and conditions for school and district science programs, focus on issues at the school and district levels that relate to opportunities for students to learn and opportunities for teachers to teach science. The science education system standards provide criteria for judging how well the system provides schools with the financial and intellectual resources necessary to achieve the national standards. Samples and vignettes are provided throughout the document. References are provided for each standard. (Author/KSR) ENC-006101

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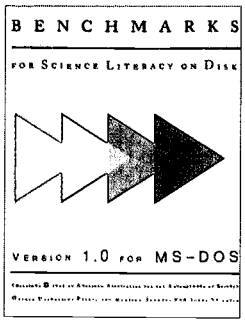
National Science Education Standards

www.nap.edu/books/0309053269/html/index.html
Grades K-12
1995
Author: National Academy of Sciences, National Academy of Engineering, Institute of Medicine, National Research Council
Publisher: National Academy Press (NAP)

At this web site, visitors can access the National Science Education Standards described above. The site houses an online copy of the standards, a press release about the book, and information on purchasing it online or by phone. Information is also available for how users can print portions of the online copy. Winner, ENC Digital Dozen, March 1996. (Author/GMM) ENC-008657

Benchmarks for Science Literacy

Grades K-12
1994
Author: Project 2061, American Association for the Advancement of Science



Project 2061 is a long-term initiative of the American Association for the Advancement of Science to reform K-12 education in natural and social science, mathematics, and technology. This book, a companion to *Science for All Americans* (SFAA), provides benchmarks of what all students should know or be able to do in science, mathematics, and technology by the end of grades 2, 5, 8, and 12. The last section describes how the book was developed and presents research findings on students' learning difficulties for the recommended topics in the book. Each chapter includes general comments on the ideas to be learned and the kinds of student experiences that would foster learning. Also included is a section introduction that comments on common learning difficulties, pacing over grade levels, and clarification of the ideas themselves. In every chapter are references to correlations in other chapters, information on what students' experiences at different grade spans might include, and what difficulties students might have. The disk version (DOS) enables readers to browse through the book, assemble and print selected collections of benchmarks, and use cross-reference features to identify conceptual connections. (Author/CCC) ENC-001752

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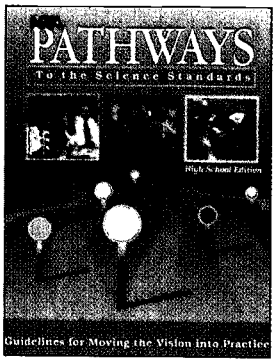
NSTA Pathways to the Science Standards

Grades 9-12
1996
Author: editors, Juliana Texley, Ann Wild

The suggestions in this book are intended to help high school teachers implement the *National Science Education Standards* (*NSES*) in their classroom. The first three chapters discuss the teaching, professional development, and content standards that apply to all K-12 teachers; specific examples are provided that relate to the high school teacher. Each chapter features a list of the standards and a chart that highlights the shifts in emphasis envisioned by the Standards. Also featured are practical discussions about each standard and a bibliography of relevant articles. The fourth chapter covers the science content outlined in the *NSES* for students in grades 9-12. The content standards have been clustered in three sections: physical science, life science, and Earth and space science. For each discipline, the book includes examples of inquiry, science and



technology, personal and social perspectives, and the history and nature of science. The text also contains vignettes from exemplary programs. The last two chapters discuss national standards for the science program and the educational system. A brief history and an outline of the *NSES* are provided in the appendices. (Author/LCT) ENC-004853

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$34.95 per book

Science for All Children: A Guide to Improving Science Education in Your School District

Grades K-6
1997
Author: National Science Resources Center; National Academy of Sciences; Smithsonian Institution

This book promotes an inquiry-based approach to teaching science at the elementary level in which children are challenged to ask questions, solve problems, and develop scientific skills. Guidelines are provided for planning and implementing an inquiry-based elementary program in any school district. In this book, the science program is viewed as a cohesive system that comprises several key elements: a research-based, inquiry-centered science curriculum; professional development; materials support; appropriate assessment strategies; and community and administrative support. These elements work together to create an interdependent system, which can be modified to meet the needs of various types of schools. The first part of the book explains the rationale for inquiry-centered science and provides some basic tools for planning such a program. The second section discusses how to implement the program by focusing on the five elements of the National Science Resources Center (NSRN) model for science education reform. In the third section, eight case studies illustrate efforts to implement the model of inquiry-centered science described in the second part of the book. An introduction, epilogue, and appendices are also included. (Author/DJS) ENC-008380

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http://books.nap.edu/books/0309052971/html/index.html

Principles and Standards for School Mathematics

Grade preK and up
2000
Author: National Council of Teachers of Mathematics Writing Group

The National Council of Teachers of Mathematics developed this volume to be a resource for all who make decisions that affect the mathematics education of students in preK to grade 12. Built on NCTM's previous three standards documents, *Principles and Standards for School Mathematics* (*PSSM*) presents a vision of school mathematics based on the belief that all students should learn important mathematics concepts and processes with understanding. *PSSM* is divided into six principles and 10 standards. The six principles for school mathematics describe the particular features of a high-quality mathematics education and address overarching themes equity, curriculum, teaching, learning, assessment, and technology. Each principle is discussed in detail in terms of the vision for school mathematics developed in *PSSM*. The 10 standards for school mathematics are descriptions of what mathematics instruction should enable students to know and do. The five content standards are number and operations, algebra, geometry, measurement, and data analysis and probability. The five process standards are problem solving, reasoning and proof, communication, connections, and representation. All standards are presented by grade bands for preK to grade 2, grades 3-5, grades 6-8, and grades 9-12. The standards define the mathematics that all students should have the opportunity to learn as they progress through the grades. Each standard comprises a small number of goals that apply across all grades, with the content standards offering an additional set of expectations specific to each grade band. The presentation of the standards is highlighted with examples of student work and examples from the classroom told in the words of teachers. The Table of Standards and Expectations in the appendix highlights the growth of expectations across the grades. It presents a concise summary of expectations related to each content standard arranged by grade band. Also in the appendix is an overview summary of expectations for the preK-12 process standards. References are included. (Author/JRS) ENC-017582

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The text of *Principles and Standards for School Mathematics* is also available via the Internet and on CD-ROM:

Principles and Standards for School Mathematics

standards.nctm.org/document/index.htm
Grades preK-12
2000
Author: National Council of Teachers of Mathematics, Standards 2000 Project

In addition to the full text of the standards, this site contains a link to the Illuminations web site, which is designed to illustrate the vision of *PSSM* with online activities for teachers and students. It also includes Internet resources to improve the teaching and learning of mathematics for all students. (Author/JRS) ENC-017737

Principles and Standards for School Mathematics—E-Standards

Grades preK-12
2000
Author: National Council of Teachers of Mathematics, Standards 2000 Project

This CD-ROM presents the full text of the printed volume along with enhanced navigation and interactive features. It also contains NCTM's three previous standards documents. ENC-018289

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Principles and Standards for School Mathematics Outreach Kit

Grades K-12
2000
Author: National Council of Teachers of Mathematics, Inc.

This outreach kit is designed for speakers to use to inform varied audiences, including teachers, administrators, parents, and community members, about the *Principles and Standards for School Mathematics* (*PSSM*). Materials in the kit include a 15-minute video that provides background information about the development process, interviews with several NCTM leaders, and a view into several standards-based classrooms. The video stresses the collaborative and inclusive nature of the writing process for *PSSM* and the need to create a document that supports mathematics learning for all children. Also found in this outreach kit are PowerPoint presentations along with speaker notes, masters for handouts, frequently asked questions, and additional background information about *PSSM* and the NCTM. (Author/JRS) ENC-018318

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Illuminations: Principles and Standards for School Mathematics

illuminations.nctm.org
Grade pre-K and up
2000
Author: NCTM Illuminations Team; director, Eric Hart

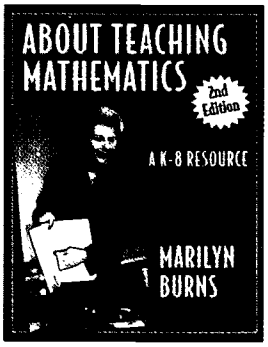
At this web site, users will find online information and activities to support and demonstrate how *Principles and Standards for School Mathematics* (*PSSM*) can be applied in the classroom. The site is divided into four grade bands: pre-K to grade 2, grades 3-5, grades 6-8, and grades 9-12, along with an additional area titled Across the Grades. A section called i-Math features ready-to-use online interactive mathematical investigations for students. These investigations include teacher notes, discussion questions, and connections to pages of the *PSSM*. In an activity for preK to grade 2, students work with an online LOGO application to find the shortest path for a turtle to walk to a pond. Students create simple programs to direct the turtle's movements as they explore the effects of direction, distance, and angle commands on the turtle's path. In another activity, designed for grades 9-12, multiple applets allow for experimentation with linear regression, the line of best fit, the effects of outliers, and the meaning of the correlation coefficient. Other sections of the site offer video vignettes of classroom activities to promote discussion, online sources of mathematical background information and support for the implementation of the *PSSM*, and lesson plans for each grade band. Also available is a searchable interactive version of the standards. Winner, ENC Digital Dozen, August 2000. (Author/JRS) ENC-016955

Implementing the Standards: General Resources

About Teaching Mathematics: A K-8 Resource

Grades K-8
2000
Author: Marilyn Burns

In this resource book are more than 240 classroom activities for students in grades K-8. The book consists of a rationale for and guide to a problem-solving approach, classroom activities divided into sections on problem solving and arithmetic, and a section on the mathematics behind 40 of the classroom activities. In the opening section on rationale, author Marilyn Burns raises what she considers to be topics basic to mathematics teaching: the content of the curriculum, problem solving as the focus of math teaching, how children learn, and the place of arithmetic in mathematics instruction.



The second part of the book introduces problem-solving activities for every area of the mathematics curriculum, including measurement, algebra, patterns, logical reasoning, and number. In the third part of the book, Burns addresses the role of arithmetic in the curriculum and how to teach arithmetic in a way that develops both understanding and skill. The final section provides discussions of the mathematics behind many of the problems and explains why the solutions make sense. The book also includes a bibliography and blackline activity masters. (Author/MM) ENC-018284

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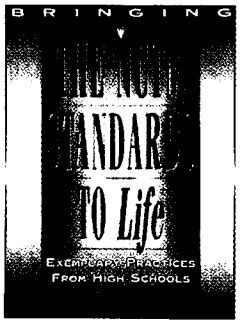
Bringing the NCTM Standards to Life: Exemplary Practices from High Schools

Grades 9-12
1999
Author: Yvelyne Germain-McCarthy

The goal of this book is to illustrate how the NCTM standards can be reflected in successful practices of teachers at the grassroots level. Focusing on how 10 high school mathematics teachers use the NCTM standards in their classrooms, the book offers practical advice on how other teachers can overcome obstacles to the implementation of standards-based practices. Included are samples of these teachers' lesson plans, student worksheets, sample exams, and other materials. Each teacher profile describes how the lesson was developed and includes a question-and-answer discussion about the lesson's relationship to reform issues. Additional chapters describe the NCTM standards documents, discuss some of the research that guided their development, and illustrate how key elements of exemplary practices—such as problem solving, reasoning, and communication—can be implemented in the classroom. In a sample lesson, algebra students explore the nature of exponential and linear growth functions with eight situation-based problems that deal with different configurations of



growth and decay versus linear climb and fall. Situations include population growth, fan club membership, and investments. Students use spreadsheets and a computer graphing program to explore the situations numerically and graphically and to find the point of intersection for each problem's graph. An extensive bibliography is included. (Author/JRS) ENC-016038

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A Comprehensive Guide to Designing Standards-Based Districts, Schools, and Classrooms

Grades K-12
1996
Author: Robert J. Marzano and John S. Kendall
Publisher: ASCD and McREL

This guide explains the events that catalyzed the creation of education standards, the way they are created and presented, and how they can be used. It discusses the assessment and reporting of student achievement based on the resulting benchmarks. Each chapter addresses a question about standards, answers it with research and practice-based evidence, and ends with a summary and set of recommendations. Tables and figures illustrate the examples discussed in the text. One chapter addresses the issue of reporting student progress. It suggests that the national, state, and district-level assessments be reported so that they can be interpreted relative to performance on specific standards. On the classroom level, the book compares reporting methods that use grades, standards, and individual benchmarks. The chapter recommends the use of individual scores on individual standards. It states that, although narrative comments are labor intensive, they complement any reporting system and that student-led conferences benefit both the students and the parents. The chapter includes sample report cards, conference scripts, and state and national standardized assessment data forms. (Author/JR) ENC-017535

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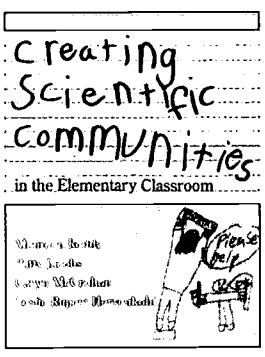
Creating Scientific Communities in the Elementary Classroom

Grades K-6
1998
Author: Maureen Reddy, Patty Jacobs, Caryn McCrohon, Leslie Rupert Herrenkohl

In this book are the results of a five-year ethnographic study of the development of early scientific literacy in an elementary school classroom. Elementary school teachers and academic researchers in the study collaborated to develop classroom environments in which, as students learned scientific concepts and procedural skills, they acquired the values and attitudes associated with successful scientific collaboration. Using transcripts of classroom conversations and samples of children's writing, the book looks at the social context of the classroom and its impact on science teaching and learning. The authors present a strategy that structures lessons much like those in a writers' workshop. Group work in science is bracketed by whole-class meetings that allow students to construct meaning through dialogue with each other and with their teacher. Throughout the lessons, the teachers use a variety of discourse strategies to support, extend, and ultimately assess their students' understanding. Bibliographic references are provided. (Author/LCT) ENC-012613



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Implementing Standards-Based Education: An ASCD Professional Inquiry Kit

Grades K-12
2000
Author: Jane Ellison and Carolee Hayes

Educators can use this professional development kit to form study groups to better understand the purpose of standards and how they can improve student learning. The kit identifies why the standards are important; how they can inform curriculum, instruction, and assessment; and how collaboration and existing resources can facilitate systemic improvements in education. Topic-specific folders contain activity booklets with articles, worksheets, and discussion starter questions based on video clips and an audio tape. The first folder includes materials and reproducible worksheets to guide the organization of study groups. Each of the other folders provides an overview of how the folder materials relate to the topic, a list of materials, and suggestions for possible activities. Also in the folders are the articles, discussion questions, and worksheets needed to carry out the activities. In one activity, group members write out the challenges, obstacles, and constraints they see in implementing standards-based education. They place their notes on a board, read them, and find common themes. They then view a related segment of the video and consider if there is anything they want to add to their list. Notes pages provide spaces to record information and a summary of key ideas. (Author/JR) ENC-018338

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Implementing Standards-Based Mathematics Instruction: A Casebook for Professional Development

Series: Ways of Knowing in Science
Grades K-12
2000
Author: Mary Kay Stein, Margaret Schwan Smith, Marjorie A. Henningsen, Edward A. Silver
Publisher: NCTM and Teachers College Press

This book offers insights into what makes a mathematics task challenging, how classroom events influence the unfolding of tasks, and how teachers can productively reflect on their practice. It is targeted toward teachers who are trying to integrate the new math standards into their current practice. The Mathematics Tasks Framework is offered as a means to evaluate instructional decisions, the choice of materials, and learning outcomes. Six classroom case studies ground the framework into actual class-

room practice. In the first part of the book, readers learn how to use the framework to analyze a classroom task by rating its cognitive demand. This section also discusses the supporting research. Part two comprises the case studies and materials for use in classes, seminars, or other instructional settings. Issues embedded in the six case studies include the role of procedures in reforming mathematics, use of manipulatives, bilingual education, and the impact of standardized testing. The case studies are based on real teachers and events, drawn from detailed documentation of classroom lessons and interviews with the teachers. The case studies aim to stay true to the predispositions and general teaching habits of the teacher who inspired the case. For each study, there is a detailed analysis of the case and discussion questions. The authors believe that the real power of the ideas and strategies contained in the book is derived from group discussion that can grow out of reading the case studies. References are included. (Author/JRS) ENC-017977

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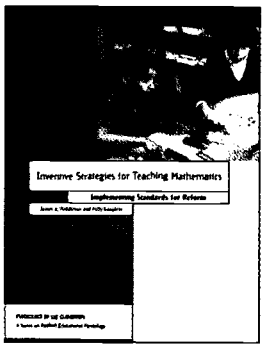
Inventive Strategies for Teaching Mathematics: Implementing Standards for Reform

Series: Psychology in the Classroom
Grades K-12
1996
Author: James A. Middleton, Polly Goepfert



Based on the vision of mathematics instruction in NCTM's *Curriculum and Evaluation Standards for School Mathematics* (1989), this book identifies five goals in implementing change: building a new understanding of the nature of mathematics, building and choosing curricula, building reaching strategies, building a balanced assessment strategy, and finding resources. Each chapter discusses a goal in depth and offers ideas for reaching it. A glossary and a list of references are included. In the final chapter, readers will find ideas to aid and support them as they strive to implement the standards. Making change is considered a process that takes time and support. Various innovative curriculum projects for all grade levels are discussed, as well as assessment, technology, parents, and teacher teams. (Author/JAR) ENC-017751

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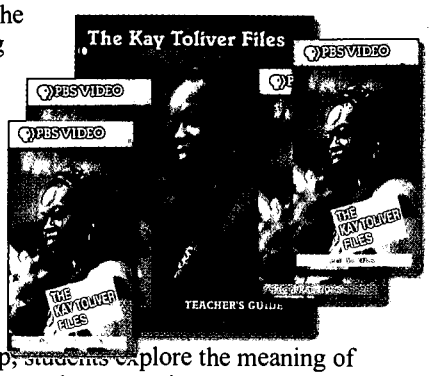
The Kay Toliver Files: File Box I

Series: Kay Toliver Files
Grades 1-8
1995
Author: Kay Toliver
Publisher: Foundation for Advancements in Science Education and PBS Video

The four videos and workshop materials in this set are designed for use in teacher education and staff development for elementary teachers. The set is part of a series in which veteran teacher Kay Toliver models teaching strategies that create a friendly classroom atmosphere, use problem solving to teach mathematics, and aim to make students see the relevance of mathematics. Each video in this set features highlights from a classroom lesson taught by Toliver and includes her comments on classroom management and the need to create mathematical understanding in students. Common objects, including cat treats, are introduced to encourage students to think about mathematics and its place in the real world. The lessons focus on teaching mathematical communication, estimation, polygons, and fractions. Toliver encourages class discussion, demonstrates how to use alternative assessment strategies, and stresses the importance of mathematics literacy. In a sample lesson, the Great Pizza Swap, students explore the meaning of equivalent fractions as they make paper pizzas. Students write a journal entry to explain the Great Pizza Swap as the final activity for this lesson. The accompanying teacher's guide includes suggestions and resources for staff development workshops utilizing the videos. Lesson plans are included along with additional classroom activities and background resources for the teacher. (Author/JRS) ENC-017928



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Learning in Overdrive: Designing Curriculum, Instruction, and Assessment from Standards

Grade pre-K and up
1995
Author: Ruth Mitchell, Marilyn Crawford, and the Chicago Teachers Union Quest Center

Teachers of any grade level can use this book to learn about a process to produce standards-based curriculum units. Working with a set of standards, teachers develop connected clusters that can be single-subject or interdisciplinary. They first determine what end result is desired and then build the unit to achieve that result. Essential to the unit is the cumulative task, which is a real-world problem that embodies all the standards included in the unit. Completion of this task by students should demonstrate that they have attained all of the standards. Once the task is determined, it is broken down into learning segments that provide the daily classroom activities. The authors contend that by starting with a list of standards and developing sufficient culminating tasks, teachers can create an effective yearlong teaching plan that will cover all the needed material. As an example of a culminating task, the book provides an interdisciplinary unit on water. Each chapter gives a narrative description of the step in the process and then relates it to the water example. The end piece in each chapter is a step-by-step description of what teachers need to do to create their own unit. Appendices include information on finding copies of various standards, forms and worksheets to help teachers through the process, and a summary of all steps in the process. (Author/SSD/TAH) ENC-016285

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Making the Standards Work at Grade 8

Series: Connect to NCTM Standards 2000
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2000
Author: Francis (Skip) Fennell, Honi J. Bamberger, Thomas E. Rowan, Kay B. Sammons, Anna R. Suarez

Part of the Connect to NCTM Standards 2000 series, this book contains four lessons for each of the five content standards: number and operation, algebra, geometry, measurement, and data analysis and probability. The nine-part series is designed to provide lesson ideas for implementing the NCTM standards at every K-8 grade level. Each book contains 20 ready-to-teach lessons. For each content standard, the book provides three standards-based lessons and one textbook-based lesson. All lessons include teaching plans, reproducible pages for student activities, lesson extensions, and suggestions for assessing student understanding. The last section of the book offers suggestions for developing lessons that incorporate the NCTM standards and that are compatible with individual teaching styles. For example, in one lesson for the algebra content standard, the students translate real-world situations into algebraic symbolism and represent the relationships graphically. Using experimentation, the students make generalizations about the effect of changing rates on slope. They then explain the story shown in each graph. (Author/JAR) ENC-017872

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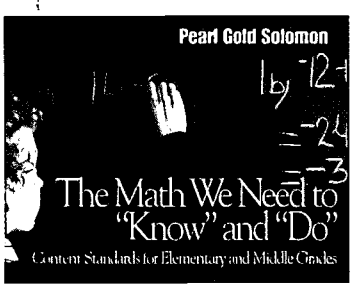
The Math We Need to Know and Do: Content Standards for Elementary and Middle Grades

Grades K-6
2001
Author: Pearl Gold Solomon

This teacher resource book links specific K-6 mathematics content and performance standards with applicable pedagogical concepts. The 200 standards in this book are functionally based on the ideas and organization developed by the NCTM and other state and local agencies. The book delineates the specific mathematics concepts that underlie the procedures as stated in the standards. Chapter one explains the rationale behind this book and explains the organization and sequence of the following chapters. Chapter two contains 200 concepts related to content and performance standards statements in a numbered table format. The table shows median grade-level expectations for each concept (labeled as exploration, concept mastery, or algorithmic mastery) as well as suggestions for mathematics vocabulary and usage. Chapter three features activities and problems that can be used with students for either concept development or assessment purposes. Suggestions are included for using manipulatives, calculators, educational software, graphics programs, and web sites in the classroom. (Author/JRS) ENC-018314



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Mathematics: What Are You Teaching My Child?

Grades K-8
1994
Author: Marilyn Burns
Publisher: Scholastic, Inc.

This 20-minute video program shows how mathematics education is being transformed by innovative teaching methods, manipulatives, and new technologies. It addresses issues such as why paper and pencil computational proficiency is not enough and how to integrate manipulatives into the classroom to help implement the NCTM standards (1989). Other issues include collaborative learning and communication, the role of problem solving and reasoning skills, and ways to build parental understanding and support for a mathematics curriculum. The presentation features comments by parents, actual classroom sequences, interviews with three professionals in the workplace, and a math challenge for teachers and students. The video is available in English and Spanish. (Author/KFR) ENC-005712

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National Science Education Standards Awareness Kit for Administrators and Supervisors

Grades K-12
1996
Author: project director, Laurie Kreindler
Publisher: The Learning Team, Inc. and the Annenberg/CPB Math & Science Project

The materials in this kit are for a workshop to help school administrators and others understand their role in building a system that supports improved science teaching and learning with the *National Science Education Standards* (*NSES*). The facilitator's workbook includes materials that can be used for small-group discussions and for formal and informal presentations to groups ranging from school boards to civic and community organizations. The workbook includes 38 color overheads with notes, background from the *NSES*, sample presentations with activities, and a variety of blackline masters. Also found in the kit are a video introducing the standards, an audiotape discussing how to make the standards work, and a poster. (Author/JRS) ENC-013322

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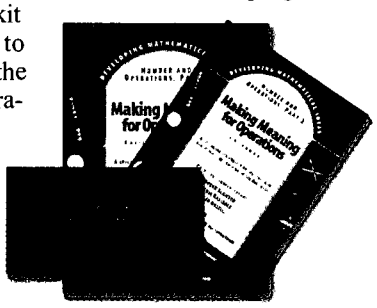
$125.00 per kit
$19.95 per video (includes four separate segments)
$3.00 per poster

Number and Operations, Part 2: Making Meaning for Operations

Series: Developing Mathematical Ideas
Grades K-6
1999
Author: principal investigators, Deborah Schifter, Virginia Bastable, Susan Jo Russell



Part of the Developing Mathematical Ideas (DMI) program, this professional development kit contains seminar materials to help K-6 teachers explore the meaning of arithmetic operations and understand how students develop these concepts. The DMI program offers field-tested seminars examining the big ideas in elementary school mathematics. Each seminar is designed as a stand-alone course typically presented over a full year to teachers who meet at regularly scheduled intervals. Seminar materials include a facilitator's guide with detailed agendas and background reading on the issues of facilitating teacher change; a casebook for each participant; and a video showing students in classrooms organized around student thinking. The participant's book contains 28 cases that explore the types of actions modeled by addition, subtraction, multiplication, and division, and the ways in which students come to understand these operations for whole numbers and fractions. The introduction to each chapter describes the set of cases, highlights the general mathematical themes they address, and includes questions to consider while reading the cases. At each session, participants discuss the cases and engage in a related mathematics activity designed to be challenging to adult learners. During the sessions, participants examine innovative curricular materials, consider research findings related to mathematics education, and create and discuss a portfolio of their assignments. References are included. (Author/JRS) ENC-018073

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$64.75 per facilitator's package (includes casebook, facilitator's guide, video) Bulk discounts available. Contact vendor for details.

Patterns & Functions: What Comes Next?

Series: Mathematics: What's the Big Idea?
Grades K-8
1997
Author: produced by Smithsonian Institution Astrophysical Observatory and Massachusetts Corporation for Educational Telecommunications

The first video in the Mathematics: What's the Big Idea series, this program sets the stage for the whole series and demonstrates how students' explorations of patterns grow richer and more complex as they move through school. The series presents eight programs in a workshop format designed to help teachers learn mathematics in new and exciting ways. Teachers learn how to teach mathematics in these ways and watch teachers in classrooms that are changing. The videos include guest teachers engaging in group discussion, activities and questions for the viewer to do and discuss, and suggested classroom activities for students. This video explores how the idea of predictability forms the basis of mathematics and introduces some mathematical activities in which patterns are central. Video clips show students in pre-K to middle school working with patterns in activities that range from simple-patterned songs and stories to generalized functions represented by mathematical expressions and graphs. The guest teachers discuss how pattern activities support mathematical understanding and the role of group work and assessment in the mathematics classroom. The series guide contains outlines of the themes, activities, and supplies needed for active participation in the video workshop format. Each workshop is correlated with specific standards from the NCTM Curriculum and Evaluation Standards for School Mathematics (1989). (Author/JRS) ENC-014174

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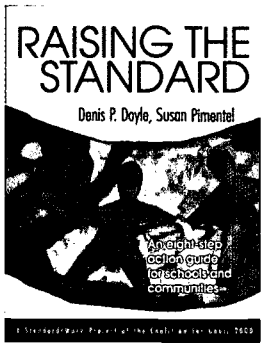
$24.95 per video
$199.00 per series (8 tapes/guide)

Raising the Standard: An Eight-Step Action Guide for Schools and Communities

Grades K-12
1997
Author: Denis P. Doyle, Susan Pimentel

This book, with its accompanying CD-ROM and web site, describes how to use an eight-step process to implement standards-driven education reform on the local level. The book provides an overview of the topic, while the CD-ROM and the online version provide more depth. The web site is an electronic service of the Coalition for Goals 2000, which is an alliance of national organizations working together to help communities and schools achieve educational goals. Visitors to the site can read standards-related articles and link to additional standards resources. The eight-step process guides readers through a standard-based school reform that is designed to preserve and reinforce local control while increasing public accountability. It requires the community to use new strategies and tactics that connect education stakeholders to a common vision. The authors suggest that, although the steps appear to be linear, many of them are best executed simultaneously or in quick succession. The process is cyclic, moving from community involvement to action and then to assessment. Throughout the book are tips for completing the steps and examples from communities in which the steps were tested. A checklist of the action steps is provided. (Author/JR) ENC-016631



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Science and Mathematics Standards in the Classroom

Series: It's Just Good Teaching
Grades K-12
1997
Author: Jennifer Stepanek

Part of the It's Just Good Teaching series, this booklet presents an overview of the vision and rationale in the national standards documents and reviews the current literature related to the standards. This material specifically addresses issues related to the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) and the *National Science Education Standards*. Each booklet in the series contains a summary of the research and current literature on a topic, a discussion of effective strategies, and an annotated listing of related resources. This booklet offers teachers background information about the national standards, including a discussion of how the standards are based on constructivist theories of learning and recognize that students learn in different ways and at different rates. There are strategies and resources for implementing a standards-based approach to teaching. Highlighted are ideas for planning, selecting, and designing instructional tasks and units. Teachers will also find practical tools such as a checklist exploring the teaching style of standards-based teachers and a list of questions that are effective in creating classroom discourse. Also stressed is the importance of teacher self-evaluation and reflection on teaching practices. A list of related resources and a bibliography are included. (Author/JRS) ENC-016610

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Teaching Math: A Video Library 9 to 12

Series: Teaching Math
Grades 9-12
1996
Author: WGBH Educational Foundation

This video library is designed for use in preservice and inservice workshops, by individual teachers, in parent-teacher association meetings, and by school administrators. The library began when the Annenburg/CPB Math and Science Project issued a call for visual examples of dynamic high school teaching that illustrate the curriculum content and process areas outlined in the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). The collection of 10 tapes includes an introductory videotape, five tapes containing real, unscripted lessons focusing on different content areas, and four videotapes that focus on communication, reasoning, connections, and problem solving by showing excerpts from the lessons. The videos provide viewers with an opportunity to observe a wide range of teacher-created lessons from various curricula in diversified educational settings. Different lessons include applications to real life situations, technology use, and problems with more than one correct solution. In one content area video, for example, a teacher from a Boston high school conducts a small group activity with ninth graders. Groups of students try to find a pattern that tells how many blocks are needed to make different-sized staircases. Each group uses paper squares to build several staircase models, records its data on a large piece of paper, and writes down questions it encounters. The teacher moves from group to group asking and answering questions. Each video ends with analysis questions intended to spark discussion and reflection. In the staircase activity, for example, one question asks how the teacher's questions encouraged reasoning. Selected videos include interviews that give students' reactions to the classroom activities. Also included with the video is a guidebook compiled of individual units accompanying each videotape. Each unit contains a list of NCTM standards featured in the lesson, a summary of the videotape, and an exploration activity, as well as information about the classroom and a list of discussion ideas. (Author/KFR) ENC-009487

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$25.00 per guidebook
$250.00 per set (10 videos, 1 guidebook)

Teaching Science for All Children

Grades K-8
2001
Author: Ralph Martin, Colleen Sexton, Jack Gerlovich

Written for preservice teachers, this textbook takes a constructivist approach to help foster students' awareness of the nature of science, an understanding of the inquiry process, and an appreciation of the interaction between science, technology, and society. Examples of tools that the book introduces to promote understanding include analogies and concept mapping. The authors emphasize teaching for understanding and use problem solving as an assessment tool. Science, technology, and society references are incorporated in each lesson. Readers are told how to use discrepant events and real-life situations in the lessons. Scenarios introduce each chapter. Figures, tables, and black-and-white photographs, as well as exercises and featured research reports, are found throughout the book. The first part of the book discusses the importance of scientific inquiry and examines methods that promote cooperative learning. The second part explains how theories provide the foundations for the practice of inquiry learning while the third expands the readers' understanding and skills in science teaching. It covers topics that include managing classrooms, assessing student learning, and practicing science safety. The fourth part contains sample lessons and activities, which are classroom-tested and keyed to the *NSES*. The evaluation component of the learning cycle is interspersed throughout the text. A companion web site contains additional teaching and learning aids. (Author/JR) ENC-018417

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Teaching the Basics

Series: Marilyn Burns Talks About Math Teaching Today
Grades K-8
1999
Author: Marilyn Burns

In this audiotape, Marilyn Burns focuses on the importance of children making sense of mathematics as they learn to problem solve and to do mental as well as paper-and-pencil computation. She places learning arithmetic in the larger context of mathematics and explores approaches to teaching arithmetic that emphasize creating mathematical understanding as opposed to learning rote computational algorithms. Burns actively engages her audience in problem-solving tasks and forms a list of times in daily life when arithmetic is used. A discussion follows about when exact answers are important and when estimation can be used. Burns points out that knowing when to find exact answers and when to estimate is a real-life mathematical skill that students need. Using examples of student work, Burns describes the importance of communication and how students' mathematical writings can be helpful for improving teacher and student understanding. Burns concludes by stressing that, in the classroom where making sense of mathematics is the goal, there is a need for whole group instruction, small group activities, and individual reflection. (Author/JRS) ENC-018093

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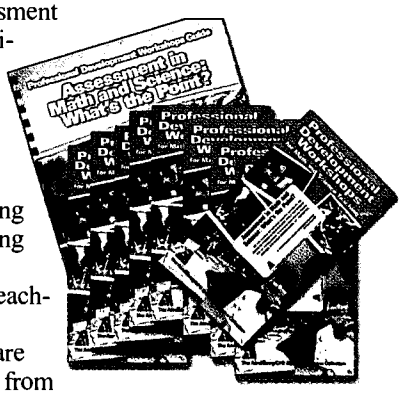
$11.95 per tape

Implementing the Standards: Assessment

Assessment in Math and Science: What's the Point?

Series: Annenberg/CPB math and science collection.
Grades K-12
1998
Author: producers, Carol Jackson, Alain Jehlen; directors, Lisa Friedman, Tom Van Horn

This set of professional development videos and accompanying workshop guide examines current assessment issues and explores strategies for assessment reform in K-12 math and science classrooms. The eight 90-minute videos use a panel format and classroom vignettes to focus workshop discussions on topics that include exploring the meaning of understanding, constructing assessment tools, and using standardized tests to focus teaching. Each video contains segments in which viewers are encouraged to use materials from the reproducible workshop guide as a basis of discussion. The guide contains workshop activities and educational background materials. In the first video, panelists and viewers use a list, The Ten Dimensions of Understanding, as a vehicle to discover the depth of student understanding shown in three classroom vignettes. In the last video, the discussion focuses on the characteristics of the change process. The roles of principals, parents, and students are explored while an emphasis is placed on what the individual teacher or small group of teachers can do to improve assessment and student learning. (Author/JRS) ENC-018191



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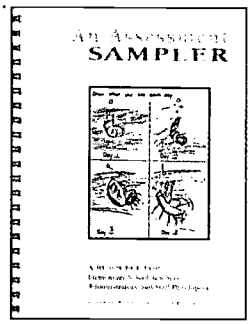
$199.00 per package (8 videos, 1 workshop guide)

An Assessment Sampler: A Resource for Elementary School Teachers, Administrators, and Staff Developers

Grades K-8
1999
Author: developed by teachers from Linden Public Schools (NJ), North Penn School District (PA), Rahway Public Schools (NJ), Readington Township Public Schools (NJ)

Compiled to disseminate the design and outcomes of the Assessment Project, this book provides an overview of the project, analysis of participating teachers' reflections, and examples of assessments tasks they designed as part of their inquiry-based instruction. The Assessment Project's design emphasized professional development through investigation of assessment alternatives. It allowed teachers to design and field-test their tasks and reflect with colleagues and project staff about what the assessments revealed about the students' science understanding. In the first two sections of the book, readers learn the details of the project, the professional development outcomes, and the teachers' reflections on the development process and execution of their inquiry-based assessments. The teachers explain how they considered the formative and summative goals of the assessments and how to customize them to fit specific learning situations. Issues of parental involvement, documentation, and evaluation are addressed. The largest section of the book contains 17 assessment tasks that illustrate the variety of methods the teachers used, such as performance tasks, journal entries, and writing and drawing prompts. Each entry contains a statement of the assessment's purpose referenced to national standards, a description of the procedure, and teachers' reflections and recommendations. Samples of students' work with teacher comments are provided for each task. (Author/JR) ENC-016097



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Assessment Strategies to Inform Science and Mathematics Instruction

Series: It's Just Good Teaching
Grades K-12
1997
Author: Northwest Regional Educational Laboratory

Part of the It's Just Good Teaching series, this booklet presents an overview of the rationale for using assessment to inform instruction and describes nine strategies for classroom assessment, including concept maps, writing activities, and portfolios. Each booklet in the series contains a summary of the research and current literature on a topic, a discussion of effective strategies, and an annotated listing of related resources. Drawing from the NCTM's *Assessment Standards for School*

Mathematics (1995), this booklet describes three broad purposes for assessment: diagnostic, formative, and summative. Included are suggestions for choosing an appropriate format for assessment, integrating assessment into instruction, and making decisions about instruction based on assessment. In this booklet, two sample student concept maps are included to help readers understand how concept maps can be used for assessment and to show how a concept map can serve as a window into the mind of a learner. Brief quotations from classroom teachers highlight the teacher's perspective on using assessment to inform instruction in actual classrooms. A list of related resources and a bibliography are included. (Author/JRS) ENC-015746

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Bibliography of Assessment Alternatives: Science

Series: Innovative Assessment
Grades K-12
1998
Author: Northwest Regional Educational Laboratory

In this bibliography, teachers of all grade levels will find a collection of alternative assessment ideas in science. Included are state assessments, classroom assessments, and national or international assessments, in addition to performance assessments, portfolios, and technical innovations. The bibliography also includes research about assessment and current thinking on what should be assessed. Various research articles address the issue of making assessment a tool for meaningful reform of school science. Each annotated entry provides an abstract as well as contact addresses for the acquisition of materials. An index is also included. (Author/YK) ENC-017838

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Keeping Score: Assessment in Practice

Grades K-12
1999
Author: Ann Shannon

This book is intended for mathematics teachers, supervisors of mathematics teachers, designers of mathematics tasks and assessments, and administrators. It discusses issues to be considered while developing mathematics assessments. Throughout the book, four ideas are addressed: balance, opportunity to perform, opportunity to learn, and alignment. The intent is to consider how the four ideas can be used to develop and implement assessment instruments. This book starts with a discussion of differences between norm-referenced and standards-based assessments. One chapter models an outline for standards-based assessment that incorporates elements necessary for the assessment to enhance instruction and learning. Another chapter focuses on the issues that influence opportunities to learn. The book concludes with a discussion of the issue of aligning instruction and assessment with standards. (Author/JAR) ENC-017943

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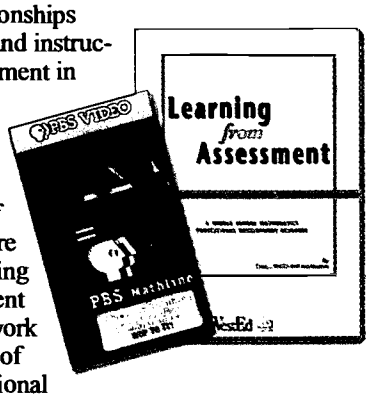
Learning from Assessment: Tools for Examining Assessment Through Standards

Series: PBS MATHLINE: Algebraic Thinking Math Project
Grades 5-8
1999
Author: Tania J. Madfes, Ann Muench, Ann Lawrence; L. Carey Bolster, Jill Peters, Christopher Seward
Publisher: WestEd and NCTM and Thirteen/WNET



In this professional development resource kit are materials for three modules designed to help middle school teachers bridge standards and classroom practice. In the two-hour sessions, teachers examine the interrelationships among assessment, standards, and instruction to improve student achievement in mathematics. Items from large-scale assessment projects such as the Third International Math and Science Study (TIMSS) and the National Assessment of Educational Practice (NAEP) are used as focal points for discussing critical issues that support student learning. Session participants work together to clarify the meaning of standards on both local and national levels, evaluate assessment tools in terms of their alignment with middle school mathematics standards, and plan student learning experiences that reflect standards-based teaching. Included are suggestions for using the Mathline video *Hop to It!* to show how a grade 8 TIMSS item can be used to probe student thinking. Facilitator support materials include planning tools, masters for all transparencies and handouts, four supplementary activities, and selected references. (Author/JRS) ENC-016033

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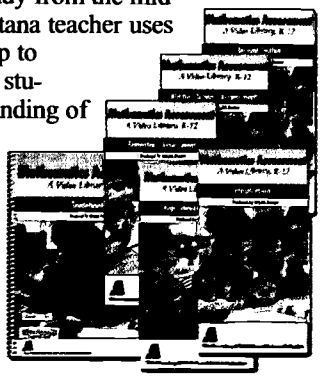
$31.00 per kit (includes loose-leaf text and video)

Mathematics Assessment: A Video Library, K-12

Grades K-12
1997
Author: producer, Robert Roche

The case studies in this video library are drawn from K-12 classrooms to illustrate a range of assessment approaches based on NCTM's *Assessment Standards for School Mathematics* (1995). The videos and related guidebook are designed to prompt discussion and reflection about changing assessment practices and to help viewers see the link between instruction and assessment. The introductory video acquaints viewers with the library and its components, and three case-study videos illustrate a variety of assessment strategies at the elementary, middle, and high school levels. The final video addresses the changing nature of assessment through discussions and interviews with teachers, administrators, parents, and policy makers. Each case-study video presents two cases, analysis questions for

viewer reflection and discussion, and a teacher insight segment showcasing multiple examples of the implementation of the assessment standard. In one case study from the middle school assessment video, a Montana teacher uses student observations from a field trip to Yellowstone National Park to assess students' estimation skills and understanding of large numbers. In the video, after the class estimates the total number of bison, elk, and pronghorn, groups of students use a park map and information on an assigned animal to revise the class estimate for the population of that animal. One question for viewer discussion asks: How can peer assessment contribute to learning? The guidebook provides background on the schools and classes featured in the videos, exploration activities, and discussion topics for workshops and planning sessions based on individual case studies. (Author/JRS) ENC-014526



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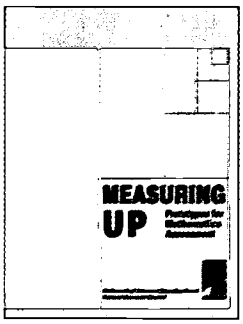
$17.00 per guidebook

Measuring Up: Prototypes for Mathematics Assessment

Series: Perspectives on School Mathematics.
Grades K-12
1993
Author: Mathematical Sciences Education Board, National Research Council

This book is for developers of tests and other assessment instruments, teachers, and university-based educators responsible for prospective teachers. The book provides examples of tasks that can be used to assess mathematical skills and knowledge as expressed in the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). The 13 tasks are generally organized as a sequence of questions, often in order of increasing difficulty and presented in several formats. Many of the tasks involve problem solving, communication, and reasoning. These tasks require the student to explain underlying patterns, relationships, or reasoning. For each task, the book provides a recommended time allotment, suggestions for student grouping, background information, and a rough scoring system. In the task called Lightning Strikes Again, for example, four people see lightning strike at a point but, because sound travels more slowly than light, they do not hear the thunder right away. One question asks who hears the thunder first and why. Another question supposes that the lightning strikes again at a different place. Two people, at different locations, hear the thunder at the same time, and students must show on a map where the lightning might have struck. A bibliography is included. (Author/LDR) ENC-007090



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Science Process Skills: Assessing Hands-on Student Performance

Grades 1-6
1992
Author: Karen L. Ostlund
Publisher: Addison-Wesley Publishing Company, Inc.

These activities offer students the opportunity to demonstrate mastery of science process skills. Divided into six levels, the activities assess the following process skills: observing, communicating, estimating, measuring, collecting data, classifying, inferring, predicting, making models, interpreting data, making graphs, hypothesizing, controlling variables, defining operationally, and investigating. For each assessment, the book provides a materials list, procedure, blackline masters, and an answer key. (KSR) ENC-001429

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www.pearsonlearning.com
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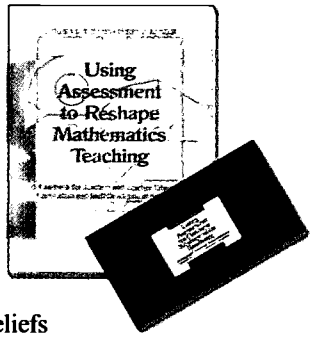
Using Assessment to Reshape Mathematics Teaching: A Casebook for Teachers, Teacher Educators, Curriculum and Staff Development Specialists

Grades K-12
2000
Author: editors, Sandra K. Wilcox and Perry E. Lanier

This casebook and its accompanying video contain seven case studies that explore classroom-based assessment as a way to enhance opportunities for all students to develop mathematical power. The material is designed to enhance teacher learning and to support change in assessment practice. All case studies are correlated to NCTM Professional Teaching Standards to help teachers link assessment with curriculum, teaching, and learning. Each case includes an overview and introduction, suggested participant activities for investigating the case, and reproducible support materials such as samples of student work, recorded observations of student engagement, and questions for analysis. A sample case focuses on children's early algebraic thinking as students observe, describe, represent, and generalize patterns. Teacher participants are asked to examine their own beliefs about working with algebraic ideas in elementary classrooms. They consider how the students in the sample case were thinking, what types of tasks the teacher had posed, and what the teacher would need to know about algebra to teach it to young students. Included with this case are samples of students' written work and edited videos of students explaining their reasoning about patterns in the tables they developed. Also found are the teacher's notes and her reflection and commentary on the lesson. (Author/JRS) ENC-017980



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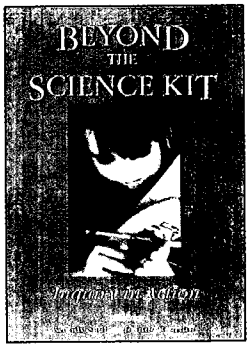
Implementing the Standards: Inquiry and Problem Solving

Beyond the Science Kit

Grades pre-K-5
1996
Author: editors, Wendy Saul and Jeanne Reardon

The essays in this book encourage teachers to attend to the values that improve science instruction and recognize that science kits are just the beginning of scientific inquiry. It emphasizes that science must be local, personal, and relevant. The editors claim that if published materials are used in a prescriptive fashion instead of in a way that connects with the individuals, the kits take the students further from authentic science. The essays describe teachers' experiences as they modified their techniques to expand kit activities so that students could become producers as well as consumers of scientific knowledge. The book explores how teachers can learn to improve their instructional inquiry methods, discusses the values upon which inquiry-based science is built, and describes what it looks like when the instruction connects the science with the students daily lives. One essay compares the teacher's discovery process to that of her students. The teacher describes how she watches birds on hikes and from her home with her husband. They collect information, ask questions, and then develop a plan to answer their questions. They conduct small-scale experiments and share their information with others. The teacher explains how students follow the same patterns in their approach to reading and exploring the world around them. (Author/JR) ENC-017168



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CIBL, Center for Inquiry-Based Learning

www.zoology.duke.edu/cibl
Grade pre-K and up
2000
Author: Norman Budnitz
Publisher: Center for Inquiry-Based Learning, Department of Biology, Duke University

This web site, maintained by the Center for Inquiry-Based Learning at Duke University, contains inquiry-based science and mathematics activities. CIBL is a group of scientists and science educators who develop exercises and train teachers in the use of multidisciplinary, hands-on, minds on, discovery methods for teaching science. The activities are linked from an annotated list and a table in which they are correlated with process skills and North Carolina educational standards. In one activity, students in grades 5-12 explore the difference between analogous and homologous structures when they try to detect an imposter in a group of fruits. The class discusses the characteristics of fruits and then small groups of students inspect the specimens internally and externally. As an extension, the students look at seeds with different seed dispersal methods and discuss how each method might work. (Author/JR) ENC-018221

Designing Project-Based Science: Connecting Learners Through Guided Inquiry

Series: Ways of Knowing in Science
Grade K and up
2000
Author: Joseph L. Polman

In this book, graduate student Joseph Polman presents findings based on his qualitative research on the pedagogy of project-based science. Topics discussed include historical background on the use of project-based learning in schools, logistical issues of managing time and resources, and an examination of how the school culture affects guided participation. There is also a critical evaluation of previous empirical research in this field and extensive narrative that describes the daily events and challenges the author observed in one project-based Earth science classroom. The author analyzes the demographics of the students who take the class and describes their attitudes and expectations using quotes from interviews and surveys. By combining these data with student assessments, college admission data for the sample population and teacher observations, the author builds an argument for the usefulness of project-based learning. Polman emphasizes the role of technology, the importance of teaching students how to do science, and the reflections of the teacher at the center of the study. There are practical suggestions on establishing a project-based classroom and numerous illustrations of the kind of pitfalls that await a fledgling program of this kind. A methodological biography that describes the author's data collection methods is included as an appendix. (RJD) ENC-017689

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$23.95 per book (paperback)

Fostering Children's Mathematical Power: An Investigative Approach to K-8 Mathematics Instruction

Grades K-8
1998
Author: Arthur J. Baroody with Ronald T. Coslick

This book illustrates and describes the investigative approach to teaching mathematics, which embodies the three central tenets of the 1989 NCTM standards for mathematics teaching and learning: making mathematics relevant to the everyday lives of students, making mathematics learning problem-based, and making mathematics meaningful to students. The text presents a series of inquiry activities that promote the exploration of key ideas about mathematics, children's mathematical learning, and mathematics teaching. The activities are intended to engage readers in problem solving, reasoning, communicating, conjecturing, discovery learning, and resolving cognitive conflict in both the context of mathematics and of mathematics teaching. The text also addresses mathematics instruction as it pertains to particular aspects of the K-8 content, such as number sense and arithmetic from whole numbers to rational numbers, geometry and measurement, statistics and probability, and pre-algebra concepts. The pages are perforated so that material can be reorganized or mixed with material from other sources to form a personalized teaching manual. (Author/GMM) ENC-015323

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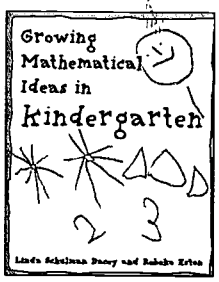
Growing Mathematical Ideas in Kindergarten

Grade K
1999
Author: Linda Schulman Dacey, Rebeka Eston

This book presents a vision of a kindergarten classroom that allows the growth of students' mathematical understanding. It provides specific guidelines for how to create such a classroom environment, including how to plan for a full year of teaching and learning mathematics. The book provides guidance on how to choose mathematical tasks and assessment of understanding. Many samples of student work are included to illustrate what children are capable of doing with mathematics. Appendices provide references for using children's literature and 25 favorite books for supporting mathematics instruction in the kindergarten classroom. (Author/JAR). ENC-017212



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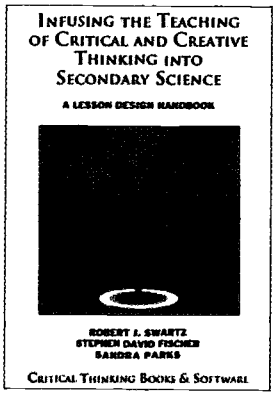
Infusing the Teaching of Critical and Creative Thinking into Secondary Science: A Lesson Design Handbook

Series: Lesson Design Handbook
Grades 6-12
1998
Author: Robert J. Swartz, Stephen David Fischer and Sandra Parks

The authors of this book present a teacher-oriented approach, known as infusion, to improving student thinking that blends educational theory and practice. The handbook describes how teachers can guide their students to perform ordinary thinking activities. Key questions that effective thinkers raise and answer are organized into thinking plans that can be used to guide good thinking. The plans fall into three categories: skills at generating ideas, skills at clarifying ideas, and skills at assessing the reasonableness of ideas. Clarifying skills, for example, include comparing, classifying, and sequencing, while assessing skills include use of evidence and deduction. The book begins with an explanation of the infusion process and the progression and hierarchy of thinking skills. Subsequent chapters describe how to use graphic organizers to guide students' thinking with respect to decision making and problem solving, analyzing arguments, and reasoning by metaphor and analogy. In a sample lesson plan for grade 9, students learn how to evaluate resources as they work on a library research project. After choosing a topic, students compare the books and articles they find and develop a list of questions they would need to answer to decide which sources are likely to give them accurate information. Each lesson plan includes sample discussion questions and responses, webbing and brainstorming charts, and a list of ideas for using the technique to teach topics in biology, chemistry, earth, and space science. (Author/LCT) ENC-017621



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Inquiry and the National Science Education Standards: A Guide for Teaching and Learning

books.nap.edu/html/inquiry_addendum/index.html
Grades K-12
2000
Author: National Research Council
Publisher: National Academy Press

At this web site visitors will find the first of the planned addenda to the National Science Education Standards (*NSES*). The guide discusses the meaning and multiple roles of inquiry in the classroom, summarizes the research and scholarly writings that argue for the value of inquiry in science education, and identifies actions that need to be taken to support inquiry in the classroom. It was developed to improve teaching and learning, explain and promote inquiry-based methods, and guide scientists' work with teachers. Readers can learn where in the *NSES* they can find information about inquiry. The text also discusses classroom assessments and answers frequently asked questions about inquiry methods. Vignettes of teachers and students engaged in and learning about inquiry are used to illustrate ideas in the text. The appendices elaborate on excerpts from the *NSES* and explain how to use worksheets when selecting instructional materials that promote inquiry. Included is a bibliography of resources for teaching science through inquiry. (Author/JR) ENC-018105

Inquiry Strategies for Science and Mathematics Learning

Series: It's Just Good Teaching
Grades K-12
1997
Author: Denise Jarrett

Part of the It's Just Good Teaching series, this book presents an overview of the rationale for using inquiry-based teaching and offers specific strategies that teachers can use in the classroom to facilitate student learning of concepts and skills. Each booklet in the series contains a summary of the research and current literature on a topic, a discussion of effective strategies, and an annotated listing of related resources. This publication addresses issues such as creating new roles for students and teachers, choosing and presenting an inquiry topic, and using classroom discourse and questioning. Included are suggestions for using the Learning Cycle strategy, a model to facilitate inquiry learning developed in the 1960s. The strategy uses questions, activities, experiences, and examples to help students develop a concept, deepen their understanding of it, and apply it to new situations. The need for the teacher in an inquiry-based lesson to be well prepared in the subject area is stressed. Highlighted is an inquiry-based lesson where middle school students in Montana investigate the question: What affects the period of a pendulum? A list of related resources and a bibliography are included. (Author/JRS) ENC-016611

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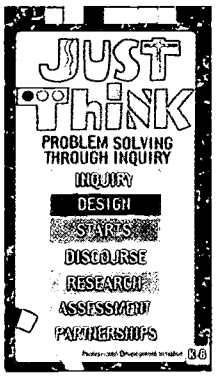
Just Think: Problem Solving Through Inquiry

Series: Just Think: Problem Solving Through Inquiry
Grades K-8
1996
Author: principal investigator, Edward T. Lalor

All seven programs in the Just Think: Problem Solving Through Inquiry series are featured on this video, which shows how the components of real-world problem solving can be used in learning situations. Each episode provides footage of situations in which people perform activities necessary for inquiry learning, such as design, discourse, and collaboration. Viewers see K-8 students exploring and refining their understanding about the world around them as they go on field trips, carry out research projects, and play outside. The series also shows adults modeling problem-solving skills in the workplace. The video emphasizes that inquiry makes the students responsible for their own learning. One segment demonstrates how assessment is an integral part of the inquiry process. In it, scientists working at a testing facility for consumer products show how assessment is crucial to the generation of results that are useful to both manufacturers and consumers. Teachers discuss the importance of embedded assessment to determine how much students have learned. Children review each other's presentations in 4H projects as an example of peer assessment. The impact of effective assessment on children's learning, performance, and self-concept is discussed. (Author/JR) ENC-017898



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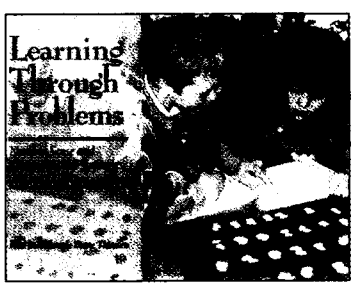
Learning Through Problems: Number Sense and Computational Strategies, A Resource for Primary Teachers

Grades 1-3
1999
Author: Paul R. Trafton and Diane Thiessen

This resource book is written to teach educators about problem-centered learning, an approach to mathematics instruction that honors children's thinking and sense-making ability. The approach weaves elementary mathematics topics, including addition, subtraction, place value, and problem solving, into a variety of contexts that allow for genuine mathematical exploration. The first part of the book demonstrates this approach through the classroom activities and outcomes resulting from using the Pizza Problem Story. The Pizza Problem Story illustrates what the authors term the four characteristics of a good problem: challenging nature, accessibility for all students, existence of a variety of solution strategies, and worthwhile mathematical ideas. Students are asked to use problem solving skills to find how many eight-slice pizzas are needed for a class party where each person eats two pizza slices. Descriptions of the activities include pictures of student presentations and oral and recorded examples of student work. The next section of the book, Questions Teachers Ask, addresses planning, implementation, and instructional issues related to problem-centered learning. Classroom examples show how number sense and computation skills can both be learned within a problem-centered framework. Later sections of this book contain information about the development of children's mathematical thinking, teacher reflections on classroom experiences with problem-centered learning, and ideas for assessing student learning. References include articles and reports offering the theoretical foundation of problem-based learning as well as curriculum resources and children's literature suggestions. (Author/JRS) ENC-014532



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Toucan 2000

http://www.classtech2000.com/toucan/t20index.htm
Grades 9-12
2000
Author: webmaster, Jewel Reuter
Publisher: Hope College and ClassTECH 2000

This web site contains the materials related to and generated by the Toucan Project, a National Science Foundation project housed at Hope College. The site describes the objectives and agenda for current workshops and provides lessons produced during prior classes. The materials stress the importance of inquiry-based learning and include lesson plans with teaching tips, background information, and student pages. Visitors can follow a link to a synchronous discussion site where they may participate in conversations originating from the Toucan virtual class about inquiry teaching. In one of the lab activities, called Gotta Count Stomata, teachers use the five Es teaching framework (engage, explain, explore, elaborate, and evaluate) to help students design their own experiments based on the number of stomata on leaves. Students are asked to analyze their results, evaluate their experimental design, and consider practical applications of their newly discovered information. (Author/ JR) ENC-017917

Twenty-Twenty: Activities and Projects for WILD School Sites

Series: Ohio Project WILD Action Guide
Grades 3-12
1999
Author: Paul D. Schiff

The projects and activities in this book are designed to encourage teachers and students to enhance and use the school site as part of a comprehensive, multidisciplinary environmental education program. The goal of the book is to help students gain an appreciation for the needs and value of wildlife as well as how the activities of humans impact it. The authors emphasize that performing the activities on school grounds simplifies the prerequisite arrangements and increases the students' feelings of ownership. The projects were developed to be used with the class's existing environmental education program. The focus of the projects and activities is the creation of a place for wildlife

on the school site. The projects and activities in the book are meant to be adapted to individual situations and grade levels. The projects involve students enhancing the schoolyard environments with features such as feeding stations, bird baths, and gardens. In one project, students create shelters for reptiles and amphibians. The directions explain how to build houses for toads and snakes. The activity pages contain learning objectives, background information, and a materials list as well as procedural directions and extension ideas. The activities in the book ask the students to make observations and conduct investigations in the wildlife regions of their school yard. One activity asks students to place a sock over their shoe and walk through a grassy field to simulate the way that animals help plants distribute their seeds. The seeds on the socks are analyzed in terms of shape and size and then students consider how the socks are similar to mammal fur. As an extension, students walk in different locations and compare the seeds that are collected. They create an environmental map of the ecosystems' differences represented by the collected seeds. Black-and-white drawings illustrate the directions for the projects and activities. (Author/JR) ENC-017120

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Free book (paperback)

Implementing the Standards: Integrating Technology

Calculator Based Biology: A Biology Laboratory Manual Using Probeware and Graphing Calculators

Grades 9-12
1996
Author: Robert S. Goodman

This manual contains 40 biology laboratory activities, some of which require the aid of probeware and calculators. More than one-half of the activities give students the experience of conducting controlled experiments. In six of the labs, students are required to apply previously learned skills in designing their own controlled experiments. Questions direct the students to review the experiment's concepts and consider further research. Line drawings illustrate the experimental setups and organisms under investigation. Space is provided for data collection and analysis. Topics covered in the book include biochemistry, cell biology, and animal and plant physiology as well as development, evolution, and ecology. In one experiment, students compare the rates of respiration between germinating peas and mealworms. A graphing calculator and gas pressure sensors are used to measure the oxygen consumption of the two organisms. The directions tell the students to determine the masses of peas and the mealworms. The book then explains how to set up the calculator and the sensors. After the data are collected, the manual tells how to manipulate them into a meaningful form. The students plot their data and compare the slopes of their graphs of pressure change versus time. As an extension, the book suggests that students compare the respiration rates of other organisms or the same organisms under different conditions. (Author/JR) ENC-017512

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(718) 543-8376
$30.00 per lab manual

Computers, Teachers, Peers: Science Learning Partners

Grade pre-K and up
2000
Author: Marcia C. Linn, Sherry Hsi

This book and companion videotape describe the Computer as Learning Partner (CLP) project, an initiative to study how the interaction between computers, teachers, and peers can help students build on their ideas and become lifelong science learners. The book also provides an instructional framework that new partnerships can use to get a head-start on curriculum design. Section I introduces Pat, Chris, Lee, and Sasha, four students who follow the CLP curriculum from grades 8 to 12. Section II describes how the CLP curriculum was designed, tested, and refined to promote lifelong science learning. This section also presents four pragmatic pedagogical principles: making science accessible, making thinking visible, helping students learn from each other, and promoting lifelong science learning through project-based learning. Section III examines science learning from the perspective of the four students introduced in the case studies and compares their descriptions with evidence from their science class performance. Section IV discusses how information gained from the CLP project can be used to design effective instruction that emphasizes making technology a learning partner. The video shows physics students working with a classroom teacher to learn science and explores the answers to four questions: Can we make science accessible? Can we make thinking visible? Can students learn from each other? and Can students become lifelong learners? The students are engaged in real-time data collection, graph interpretation, classroom debate, and critique of Internet evidence as they study heat, temperature, light, and energy conversion. The text is also supplemented by a CD-ROM (included with the book) and a companion web site that offer the complete CLP curriculum and lesson plans for units on heat, light, and sound. (Author/LCT) ENC-017665

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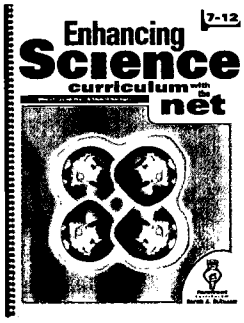
Enhancing Science Curriculum with the Net, Grades 7-12: Internet Lesson Plans and Student Handouts

Grades 7-12
2000
Author: Sarah A. DiRuscio

This guide is intended to help teachers use the Internet effectively to enhance student instruction by accessing information, sharing resources to solve problems, and publishing student work. The guide contains tips for locating information on the Internet, such as free technology integration courses, Internet-

based lesson plan databases, and science fair resources. The first section of the book presents essential knowledge for successfully integrating the Internet into the science classroom, including history of the Net, fair-use policies, and citation methods. The second section provides activities and step-by-step directions to help students develop critical navigation, evaluation, and research skills. In the third section are activities such as social action and global classroom projects that teach students to analyze the problems in a scientific manner. The fourth section provides examples for collaborative science projects in which students correspond with expert scientists and students from around the world to enhance their classroom projects. The last section focuses on the key components of developing a classroom web site and highlights some student- and teacher-developed web sites. An Internet glossary is also included. (Author/FCM) ENC-018153



Also available is *Enhancing Science Curriculum with the Net, Grades K-6: Internet Lesson Plans and Student Handouts* (ENC-018138)

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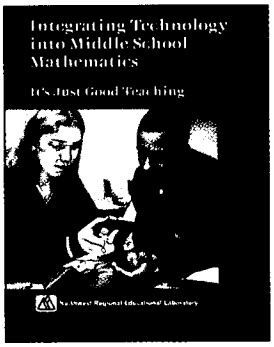
Integrating Technology into Middle School Mathematics

Series: It's Just Good Teaching
Grades 5-8
1998
Author: Denise Jarrett

Part of the It's Just Good Teaching series, this booklet presents technology as an integral element of instructional strategies and addresses the opportunities and challenges that are posed by the use of technology. It provides a variety of real-life examples of technology applications in middle school classrooms. Material in this booklet explores the creation of authentic learning experiences; equity issues related to access, gender, and students with special needs; and the variety of common instructional technologies available. Suggestions are given for introducing technology with minimal resources. The book discusses selected highlighted classrooms in which middle school students gather and record data as part of a water ecosystem project, work with graphing calculators to increase their understanding of functions, and use the Internet to gather information for mapping the ocean floor off the coast of Alaska. Included are Internet safety guidelines, examples of parent and student permissions, a list of related resources, and a bibliography. (Author/JRS) ENC-016656



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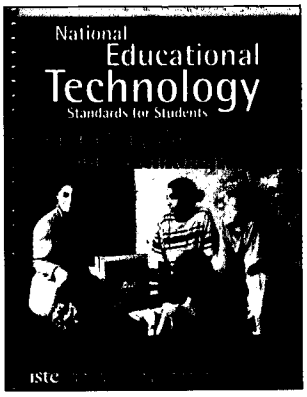
National Educational Technology Standards for Students: Connecting Curriculum and Technology

Grades K-12
2000
Author: development coordinator, M.G. (Peggy) Kelly

Teachers, technology planners, teacher preparation institutions, and educational decision makers can use this book to find frameworks, standards, and performance indicators to help enrich learning environments with technological support. The book contains descriptions of the technology foundation standards for students, activities that facilitate the integration of the standards into the curriculum, and multidisciplinary resource units that are sequenced for the National Education Technology Standards (NETS) within grade-level ranges. Performance indicators are listed and correlated to six standards for each grade range. The book provides scenarios and examples to illustrate how teachers have incorporated the performance indicators into their lessons. Another section of the book focuses on how technology can be used to enhance discipline-specific curriculum. It offers suggestions about how to manage classrooms that are equipped with different amounts of computer hardware and software. The book provides the purpose, preparation, and procedures involved in the activities as well as the tools and related resources. Each step of the procedures is correlated with discipline standards and grade level-specific NETS performance indicators. Assessment ideas are included. Another section of the book includes multidisciplinary, thematic curricular units that provide background information, related technology, and resources. Each unit has a table that lists the activities, standards, tools and resources. Appendices contain both the NETS for students and the standards for the curricular areas, a NETS Workshop Staging Guide, and information on the NETS Project Partnership. (Author/JR) ENC-016551



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National Educational Technology Standards for Teachers

Grades K-12
2000
Author: International Society for Technology in Education

In this booklet are the International Society for Technology in Education's (ISTE) technology standards for students and teachers with performance indicators and profiles for each stage in their education. The book explains the expanded roles that students can take in technology-enriched classrooms and identifies the differences between traditional and new learning environments. The standards and performance indicators are meant to guide teachers in their creation of learning experiences that enable students to achieve the competencies in a meaningful way. The student standards cover technology operations and concepts; social, ethical, and human issues; and the different categories of technology tools. The profiles identify benchmarks

for students in grades preK to 2, 3-5, 6-8, and 9-12. The six teaching standards address technology operations and concepts; classroom issues; and social, ethical, legal, and human issues. The profiles are divided into sections based upon the stages in teacher preparation (general, professional education, student teaching, and first-year teaching). Scenarios and examples are provided for each of these stages. (Author/JR) ENC-018189

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International Society for Technology in Education, 480 Charnelton Street, Eugene, OR 97401
Email: orders@iste.org
(541) 302-3777 / Fax: (541) 302-3778 / Toll-free: (800) 336-5191
www.iste.org/index.html
$15.00 per book with poster (poster also sold separately for $5.00.)

Network Science, a Decade Later: The Internet and Classroom Learning

Grade 6 and up
2000
Author: Alan Feldman, Cliff Konold and Bob Coulter

Based on the results of a National Science Foundation-funded research project, this book explores how the Internet can be used effectively by science teachers and students to support inquiry-based teaching and learning. The authors emphasize theoretical and critical perspectives and raise questions about the goals of education and the ways that technology impacts those goals. The first three chapters of the book describe the history and current practice of network science, while the second section examines discourse and data in depth, using both empirical data and theoretical perspectives. The final chapter takes a broader view and focuses on how the Internet should and should not be used to support student learning. The authors conclude by stating that technology will not replace teachers, but rather will provide broader student access to resources. The appendices describe five telecollaborative projects. (Author/JR) ENC-017900

Ordering Information
Lawrence Erlbaum Associates Inc., 10 Industrial Avenue, Mahwah, NJ 07430
Email: orders@erlbaum.com
(201) 236-9500 / Fax: (201) 236-0072 / Toll-free: (800) 926-6579
www.erlbaum.com
$17.50 per book (paperback)

Tools for Understanding: A Resource Guide for Extending Mathematical Understanding in Secondary Schools

www.ups.edu/community/tofu
Grades 7-12
1999
Author: project directors, John Woodward, Juliet Baxter
Publisher: University of Puget Sound

Visitors to this web site can explore the connection between mathematics and its application in everyday contexts. The site is divided into three strands of information and activities: math concepts with topical lessons related to prealgebra concepts and statistics; integrated lessons with three examples of business-related, open-ended problems for student exploration; and teacher strategies for using journaling to help students explain and expand their mathematical thinking. In one sample activity, students bring baskets of french fries to class on the first day of a three-day lesson. Students measure the length of individual french fries and count the number of fries in each basket. They record data, prepare individual spreadsheets, calculate basic statistics, and make charts using the spreadsheets. Issues related to quality control are considered as students look at variations across the data. Other lessons describe how to use calculators, word processors, and presentation software as part of the problem-solving process or as a tool for completing a project. Most lessons at this site were piloted in middle school classrooms and refined based on student performance. References offer research studies and curriculum materials related to conceptual approaches to mathematics, integrated instruction where students work on complex, ill-defined problems, and writing as a method for enhanced understanding of mathematics. Winner, ENC Digital Dozen, August 2000. (Author/JRS) ENC-016331

State Frameworks—A Sampling

The following resources are examples of valuable presentations of state standards. Most contain student activities that illustrate the standards described and may be useful even to teachers outside the state. We want to note that the sites were not selected because of the particular set of standards adopted by the state. ENC does not endorse any one state's framework. All online state frameworks can be reached through enc.org/professional/standards/state/

Print Documents

Connecticut K-12 Mathematics Program Evaluation Guide: An Evaluation and Implementation Tool

Grades K-12
1997
ENC-017940

Connecticut K-12 Science Program Evaluation Guide: An Evaluation and Implementation Tool

Grades K-12
1998
ENC-017803

Both documents are available from the Connecticut Academy for Education, 211 South Main Street, Middletown, CT 06457, (860) 346-1177 / Fax: (860) 346-2157
$15.00 per guide (loose-leaf)

Online Documents

New Jersey Science Curriculum Framework

www.state.nj.us/njded/frameworks/science/
Grades K-12
1996
ENC-018199

North Carolina Mathematics Curriculum

www.dpi.state.nc.us/curriculum/mathematics/
Grades K-12
1999
ENC-017698

North Carolina Science Curriculum

www.dpi.state.nc.us/curriculum/science/index.html
Grades K-12
2000
ENC-017468

Pacific Standards for Excellence: Mathematics

www.prel.org/programs/Ms/standards.97/m10.htm
Grades K-12
1997
ENC-017978

Pacific Standards for Excellence: Science

www.prel.org/programs/Ms/standards.97/s11.htm
Grades K-12
1997
ENC-017674

Utah Science Lesson Plans

www.uen.org/cgi-bin/websql/lessons/curriculum.hts
Grades K-12
1995
ENC-017723

First Grade Everyday Mathematics Teacher's Resource Package

Series: Everyday Mathematics
Grade 1
1998
Author: Max Bell, Jean Bell, James Flanders, William M. Carroll, Ellen Draznin, Nancy Hanvey, Laurie Leff, Herb Price, Joyce Timmons

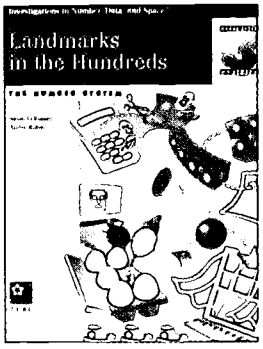
In this curriculum resource package are 110 mathematics lessons that emphasize discussion, problem solving for everyday situations, and discovery with hands-on experiences. Topics include reading and writing numbers, place value of whole numbers, and use of measurement tools. The package is part of a reform-based series from the University of Chicago School Mathematics Project. Seven content strands—Algebra, Exploring Data and Chance, Geometry and Spatial Sense, Measures and Measurement, Numeration and Order, Operations, and Patterns—are developed in a spiral fashion. The strands contain familiar elementary mathematics topics as well as applications intended to motivate the student and provide a context for traditional arithmetic. This kit has six components specifically designed for the grade 1 classroom: a teacher's manual and lesson guide; a resource book with blackline masters; a consumable student activity book; two consumable journals in which students record their mathematical thinking; Minute Math, a teacher resource with short mathematics activities for reinforcement and review; a scope and sequence chart broken down by months; and a wall chart of the numbers zero to 110. Also included in this kit is a teacher's reference manual for grades K-3, which contains background information on content, curriculum, and pedagogy. An assessment guide, also for grades K-3, contains classroom-tested techniques and masters for inventories, self-assessment, and more formal assessment of grade-specific activities. A guide is included for grade K-6 teachers and administrators on how to familiarize families with this series. Student materials are available in Spanish. (Author/JRS) ENC-012099

Ordering Information
Everyday Learning Corporation, PO Box 812960, Chicago, IL 60681
(312) 540-0210 / Fax: (312) 540-5848 / Toll-free: (800) 382-7670
www.everydaylearning.com
$180.00 per teacher's resource package
$15.50 per set of student materials

Landmarks in the Hundreds: The Number System

Series: Investigations in Number, Data, and Space
Grade 3
1995
Author: Susan Jo Russell, Andee Rubin; developed at TERC
Publisher: Dale Seymour Publications

This teacher's resource book, part of the Investigations in Number, Data, and Space series for grade 3, focuses on factors and multiples of the number 100. The series provides a complete K-5 mathematics curriculum designed to offer students meaningful mathematical problems that emphasize depth in mathematical thinking rather than superficial exposure to a series of fragmented topics. The Investigations curriculum is presented through a series of teacher books, one for each unit of study. Reproducible resources for students are provided, but the curriculum does not include student books. Students work actively with objects and experiences in their own environment and with a variety of manipulative materials and technology, rather than with workbooks and worksheets filled with problems. This book contains three investigations that each include three to seven sessions (with a session being defined as a one-hour math class). Activities include pair and small-group work, individual tasks, and whole-class discussions. A sample investigation, Finding Factors, introduces students to skip counting using interlocking cubes. By arranging 20 cubes in equal groups students find and record different ways to make 20, or factors of 20. In later sessions, students repeat this process with different numbers of cubes, moving up to 100. They then use coins to investigate ways to divide a dollar evenly among different numbers of people. Recommendations for homework assignments and for follow-up activities appear at the end of each activity. Embedded assessment activities are recommended throughout each investigation. These assessments can involve writing and reflecting, a brief interaction between student and teacher, or the creation and explanation of a product. Portfolio and observational assessments are also recommended on an ongoing basis. (Author/CMS/KFR) ENC-010364

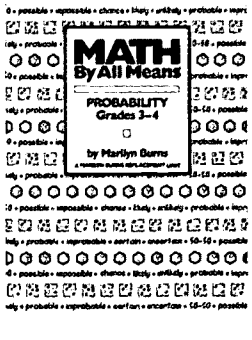


Ordering Information
Scott Foresman Addison Wesley, PO Box 2649, 4350 Equity Drive, Columbus, OH 43216
Fax: (800) 841-8939
www.scottforesman.com
$26.51 per teacher's guide

Probability Grades 3 to 4

Series: Math by All Means
Grades 3,4
1995
Author: Marilyn Burns
Publisher: Math Solutions Publications

The Math by All Means series was designed in response to the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). Each unit in the series integrates the primary topic with other strands (in this case, from the strands of number, geometry, statistics, and measurement). Writing is incorporated as an integral part of children's mathematics learning. Each book comprises four components: whole-class lessons, menu activities, assessments, and homework. The whole-class lessons provide a common set of introductory experiences on which children can build their understanding of the unit topic. Menu activities allow students to work independently, whether in groups, pairs, or individually. These activities do not build on each other, but rather pose problems, set up situations, and ask questions that help children interact with the unit topic. Homework assignments are designed for two purposes: to extend the work children are doing in class and to inform parents about the instruction their children are receiving. Woven through each unit are descriptions of what happened when the material was taught to an actual class at the appropriate grade level. These vignettes provide a view of how the lessons were organized, how children reacted, and how a teacher responded in one classroom, but are not intended as a standard of what should happen. Also described are unit goals, the organization of the book, a suggested daily schedule, and a sample letter to parents. Blackline masters are provided for menu activities and for recording sheets. (Author/GMM) ENC-007728



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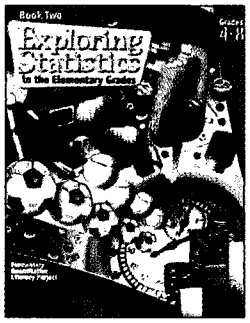
www.etacuisenaire.com
$24.95 per book
$74.95 per kit

Exploring Statistics in the Elementary Grades. Book 2. Grades 4-8

Series: Elementary Quantitative Literacy (EQL) Project
Grades 4-8
1999
Author: Carolyn Bereska, Cyrilla H. Bolster, L. Carey Bolster, Richard Scheaffer

Part of a two-book Elementary Quantitative Literacy Project, this book features investigations applying graphical techniques such as the two-way frequency table, box plot, and time plot series. These investigations build on the statistical concepts and vocabulary developed in the related introductory statistics book. The project is a collaboration of statisticians and classroom teachers offering field-tested ways to present the vocabulary and symbolism of statistics and probability. The 22 investigations in the book were written to enhance the content background of the teacher and to provide actual lessons to be adapted for students. Each investigation includes reproducible student pages and detailed teaching instructions. Background statistical information for the teacher and a glossary of terms are also provided. In a sample investigation, students gather data related to two questions chosen from a previously given survey and organize two-way frequency tables. Students construct arguments for or against the association of the two survey questions by calculating marginal proportions, conditional proportions, and joint relative frequencies. A typical question for students to consider is: Does playing sports regularly appear to be associated with playing a musical instrument? (Author/JRS) ENC-017947



Also available is *Exploring Statistics in the Elementary Grades. Book 1. Grades K-6* (ENC-017946).

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Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 321-3106
www.pearsonlearning.com
$16.95 per activity book (paperback)

Figuring All the Angles

Series: Mathematics in Context
Grades 5,6
1997
Author: Wisconsin Center for Education Research and the Freudenthal Institute at the University of Utrecht, the Netherlands

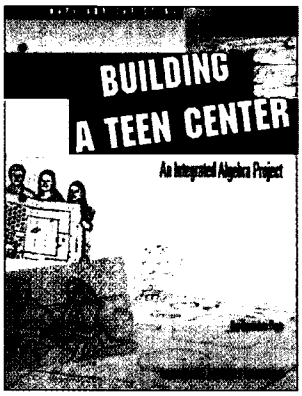
In this mathematics unit, students use a compass and angular measure to explore direction in the context of locations in the United States. This student book with teacher guide are part of the Mathematics in Context series, which offers a complete middle school curriculum encompassing ten units per grade level. Each unit is designed to place mathematical content into a variety of real-world contexts. The program's content is divided into the strands of number, algebra, geometry, and statistics. For each unit, a teacher guide includes lesson overviews, teaching strategies, student materials, and blackline masters for a letter to families, student activity sheets, and assessment. In a sample lesson, Sunray (1850), students extend the map of a small town by drawing streets parallel and perpendicular to an existing street. They also solve problems about distances on a rectangular grid. Teacher materials for this unit, part of the geometry strand, include suggestions for informal assessment, extensions, and journal writing. Also provded are formal assessment activities, such as locating two fires on a rectangular grid using directions and headings. This series reflects the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). (Author/JRS) ENC-012978

Ordering Information
Encyclopædia Britannica, Inc., Mathematics in Context, 310 S. Michigan Ave., Chicago, IL 60604
Fax: (312) 347-7966 / Toll-free: (800) 554-9862x7007
www.britannica.com
$21.55 per teacher's guide
$5.35 per student text

Building a Teen Center: An Integrated Algebra Project

Grades 6-10
1998
Author: Mary Ann Christina

This activity book involves students in a year-long project to build a teen center. The book consists of a series of 25 lessons that cover the mathematics required to solve various design problems. By promoting meaningful mathematics through application on the Teen Center project, the author wishes to distinguish between traditional algebra—which only manipulates variables and constants—and a way of thinking mathematically that uses equations to analyze important relationships. The overview section provides a description of the mathematics involved in each unit. There are five different types of activities: class, group, partner, individual, and home. In the lesson on Three Dimensional Coordinates, for example, students work through an activity in which small groups find the coordinates of objects in the classroom and each group tries to identify the other groups' objects from the coordinates. There is also a home activity in which students graph points and planes in three dimensions. (Author/MM) ENC-018254



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Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608
Email: orders@keypress.com
Fax: (800) 541-2442 / Toll-free: (800) 995-6284
www.keypress.com
$16.95 per activity book (paperback)

Variables and Patterns: Introducing Algebra

Series: Connected Mathematics
Grade 7
1997
Author: Glenda Lappan, James T. Fey, William M. Fitzgerald, Susan N. Friel, Elizabeth Difanis Phillips
Publisher: Dale Seymour Publications

This student text and teacher guide, one of the eight units available for this level from the Connected Mathematics Project (CMP) series, introduce algebra as a way of describing patterns of change. The CMP series is a complete middle school mathe-

matics curriculum that emphasizes connections among the core ideas of mathematics, between mathematics and other subjects, among classroom activities and student interests, and to applications to the outside world. Each unit contains investigations supporting problem-centered teaching and breaks instruction into three phases: launch, explore, and summarize. In this unit, students follow five college students as they plan a bicycle touring business. Students explore relationships between variables and learn how to represent these relationships in tables, graphs, written rules, and equations. In one investigation, for example, students conduct a jumping jack experiment to explore endurance over a period of time. They graph data and learn about variables, coordinate axes, scales for graphs, and plotting data points. In a mathematical reflection for the investigation, students are asked to think of other related variables and decide which is the independent variable. The teacher guide explains the mathematics in the unit and provides lesson plans, blackline masters, and suggestions for using a variety of assessments. CMP is compatible with the criteria for teaching and learning mathematics described by the NCTM in the *Professional Standards for Teaching Mathematics* and in the *Curriculum and Evaluation Standards for School Mathematics*. (Author/JRS) ENC-011862

Ordering Information
Prentice Hall School Division, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 848-9500 / Fax: (614) 771-7361 / Toll-free: (800) 848-9500
www.phschool.com
$18.97 per teacher's guide
$5.47 per student edition
$36.47 per blackline masters

Paramedics and Probability: A Five-Part Series on Indices

Series: ThinkSharp Learning Experiences
Grades 8-11
1999
Author: Coastal Film and Media

This curriculum module, part of the ThinkSharp Learning Experiences series, engages students in the story of the 1987 Amtrak crash in Chase, Maryland. Students learn how medical personnel use mathematical modeling, probability, and graphing to make lifesaving medical decisions and to evaluate the care of injured patients. The ThinkSharp Learning Experiences series offers supplemental mathematics modules that are designed to motivate students by challenging them to solve real-world career problems. Each module contains a video and teacher guide with all materials needed to prepare, teach, and assess students as they practice critical thinking, decision making, and problem solving. Also found is a correlation to selected NCTM standards. This module takes 10 hours of in-class and out-of-class time to complete all activities. In its five episodes, students see footage from train crashes and trauma centers and learn how modeling, indexing, simple probability, standardization, and regression/curve fitting are used to assess trauma patients. Medical terms and procedures are explained as students learn how patients' vital statistics and physical responses are used after a catastrophic event. At the end of each episode, a mathematical challenge is stated. For example, students are asked to calculate a score and apply triage techniques to determine which injured patients need trauma center treatment. They learn about revising trauma scores based on new information and re-evaluating survival chance. In the final episode, students use a simple graphic model to measure hospital performance based on survival rates. (Author/JRS) ENC-018409

Ordering Information
ThinkSharp, 539 Rock Spring Road, Bel Air, MD 21014
Email: contact@sharpthinkers.com
(410) 893-5338 / Fax: (410) 893-5820 / Toll-free: (888) 844-6520
www.sharpthinkers.com
$549.00 per video and teacher guide

Contemporary Mathematics in Context. Course 2.

Series: Core-Plus Mathematics Project
Grades 10-12
1998
Author: Arthur F. Coxford, James T. Fey, Christian R. Hirsch, Harold L. Schoen, Gail Burrill, Eric W. Hart, Ann E. Watkins

This curriculum program, the second course in the Core-Plus Mathematics Project (CPMP), features real-world situations and problems involving data, shape, change, and chance. CPMP is a multi-year project to develop a complete, integrated four-year high school mathematics curriculum that builds on the theme of mathematics as sense-making. The curriculum is designed to actively engage students in investigating and making sense of problem situations, in constructing important mathematical concepts and methods, and in communicating their thinking and results. There is a four-phase cycle of classroom activities: launch, explore, share and summarize, and apply. In these Course Two materials, which consist of student and teacher texts plus supplements, topics include the application of matrix modeling to inventory control and ecosystems; the use of statistical correlations and variability predictions; constructing probability distributions using simulation and mathematical analysis; and the investigation of trigonometric functions, angular velocity and periodic change. The Assessment Resources booklet contains quizzes, exams, and projects, while the Implementing the Core-Plus Curriculum booklet suggests journal prompts and ideas for portfolios. Each year ends with a capstone project. For the Course Two capstone, students plan a thematic, two-week, project-oriented activity, centered around forests and the environment, designed to pull together and apply the important modeling concepts and methods developed during the year. This course is correlated with the NCTM *Curriculum and Evaluation Standards for School Mathematics* and *Professional Standards for Teaching Mathematics*. (Author/JRS) ENC-012767

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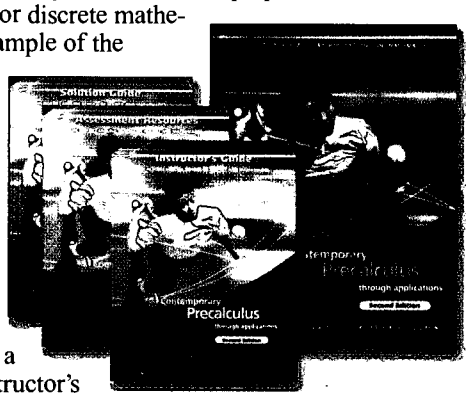
Everyday Learning Corporation, PO Box 812960, Chicago, IL 60681
(312) 540-0210 / Fax: (312) 540-5848 / Toll-free: (800) 382-7670
www.everydaylearning.com
$22.00 per student text (specify Part A or Part B)
$38.00 per teacher's guide (specify Part A or Part B)
$32.00 per assessment resources package (specify Part A or Part B)
$21.00 per teaching resources package (specify Part A or Part B)
Contact publisher for additional course materials and prices

Contemporary Precalculus Through Applications

Grades 10-12
2000
Author: Gloria B. Barrett, Kevin G. Bartkovich, Helen L. Compton, Steve Davis, Dorothy Doyle, John A. Goebel, Lawrence D. Gould, Julie L. Graves, Jo Ann Lutz

Part of the mathematics curriculum program developed by teachers of the North Carolina School of Science and Mathematics, this curriculum package contains teacher and student materials for a high school course exploring precalculus mathematics through real-world investigations. The investigations require the use of technology and focus on mathematical concepts such as mathematical modeling, functions, data analysis, and discrete mathematics. This yearlong course is designed to follow a higher-level algebra course and prepares students for a calculus, statistics, or discrete mathematics course. In a sample of the instructional material, Investigating a Conical Container, students engage in a class optimization problem to determine how to construct a cone, with the largest possible volume, from a circular material of a given radius. The instructor's guide contains a content overview for each chapter, a list of student expectations, and a planning guide. Teaching notes for each student section discuss the mathematics and point out potential difficulties for students. Other materials in this resource package include an assessment resources book that aims to help the teacher use assessment that reflects the skills valued in the standards-based classroom: communication, group participation, proficiency with technology, as well as the ability to use mathematical concepts and techniques. Also provided is a solution guide with detailed answers to all problems. (Author/JRS) ENC-016500



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(312) 540-0210 / Fax: (312) 540-5848 / Toll-free: (800) 382-7670
www.everydaylearning.com
$26.00 per instructor's guide (paperback)
$26.00 per solution guide (paperback)
$45.00 per student textbook (hardcover)
$38.00 per assessment resources (paperback) 1-57039-777-5
$130.00 per teacher's resource package

The following resources can guide selection of standards-based math curriculum programs. All are funded by the National Science Foundation.

Curricular Options in Mathematics Programs for All Secondary Students (COMPASS)

www.ithaca.edu/compass/frames.htm
Grades 9-12
2000
Author: maintained by Linda A. Roach
Publisher: Ithaca College

This web site focuses on the implementation of five multi-year, comprehensive curriculum development projects funded by NSF. A general description of each curriculum includes an outline, examples of material, evaluation and implementation data, and teacher support and resources. This site contains a three-step process to support any stage of the implementation process. (Author/JRS) ENC-018306

Show-Me Center: Supporting Standards-Based Middle Grades Mathematics Curricula

showmecenter.missouri.edu
Grades 5-8
1997
Author: webmaster, Gordon Franck
Publisher: University of Missouri

This web site provides information and resources needed to support selection and implementation of standards-based middle grades mathematics curricula. The site includes a tool that allows teachers to compare the five curricula and to view sample lessons from each program. (Author/RMK) ENC-012555

The K-12 Mathematics Curriculum Center

www.edc.org/mcc
Grades K-12
2000
Author: Education Development Center, Inc.

Part of the K-12 Mathematics Curriculum Center (MCC), this site highlights distinctive characteristics of 13 curriculum programs through a summary containing a basic overview of the approach, teacher support material, and student resources. Also available is information about standards-based mathematics curricular reform issues and related professional development seminars offered by MCC. (Author/JRS) ENC-018307

Choosing a Standards-Based Mathematics Curriculum

Grades K-12
1998
Author: Lynn T. Goldsmith, June Mark, Ilene Kantrov
Publisher: Education Development Center, Inc.

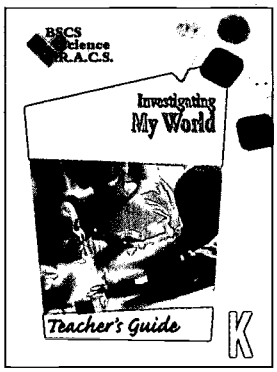
This book describes the process for considering and reviewing standards-based mathematics programs. It raises issues and questions for those involved in the selection process, such as setting appropriate evaluation criteria, assessing district needs and resources, piloting materials before selection, and planning professional development and teacher support to facilitate implementation.(Author/JAR) ENC-016829

Ordering Information
Heinemann Educational Books, Inc., 88 Post Road West,PO Box 5007,Westport, CT 06881
Email: custserv@heinemann.com
(603) 431-7894 / Fax: (800) 203-1502 / Toll-free: (800) 793-2154
www.heinemann.com
$23.00 per book (paperback)

Investigating My World, Level K

Series: BSCS Science T.R.A.C.S.
Grade K
2000
Author: BSCS Development Team

The four units in this teacher's guide are designed to be used as a yearlong science program. The series, designed for elementary school students and their teachers, provides a sequence of developmentally appropriate activities in which students actively develop concepts, inquiry skills, and problem-solving skills in authentic science and technology situations. The lessons are based on the science concepts defined by the *National Science Education Standards* and the American Association for the Advancement of Science Benchmarks. The lessons and activities in this teacher's guide can be implemented in any order. The units cover topics related to properties of objects and materials, health and safety, position and motion, and science and technology. They incorporate whole-class activities, learning centers, and stories. Each lesson begins with a brief activity that involves the entire class and ends with one or more assessment centers. Teachers can find a master list of supplies at the beginning of each unit. The teacher's guide contains blackline handout masters. Color photographs and illustrations are found throughout. In a sample activity in the unit about position and motion, students are asked to move in different ways and describe their motions. The lesson is designed to develop the students' gross motor skills as well as science process skills, such as observation, imagination, and comparison. The guide offers teaching strategies, such as asking one student to describe another student's movements or extending the activity onto the playground. A story introduces a game where one student mirrors a second student's movements. (Author/JR) ENC-017489

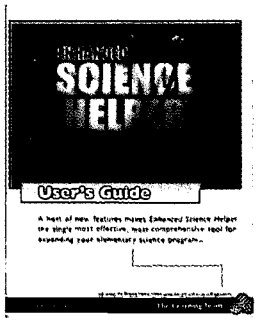


Ordering Information
Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
Fax: (800) 772-9165 / Toll-free: (800) 770-3544
www.kendallhunt.com
$169.99 per teacher's guide (loose-leaf)

Enhanced Science Helper

Grades K-8
2000
Author: project director, Sebastian L. Foti

On this CD-ROM educators will find an extensive library of more than 1,000 hands-on science learning activities and reference materials. The collection is enhanced by advanced search capabilities that allow teachers to search for lesson plans or other classroom materials by content, keyword, grade, or skill level, as well as by national standards correlation and other criteria. The package includes digital images of materials from a wide variety of sources, some of them dating back as far as the 1960s. This CD-ROM is an enhancement of an earlier version that was released in 1990. Production of the enhanced version involved the handling of more than 60,000 electronic files and the scanning of more than 10,000 real documents, as well as the development of more than 1,000 abstracts to describe the materials and the advanced search engine used to categorize and locate them. The search engine allows users to perform custom searches specifying a variety of criteria. A resource list box displays the results of each search and lets the user narrow the search progressively or scroll through the results. Clicking on the item instantly displays its abstract, which has a standardized format that includes details on the source of the item, the intended grade level, and an overview of the content. Another click takes the user to the resource itself. Most resources include the procedure for one or more specific activities as well as a list of required materials and related background information. Many of them include links to similar or related documents located elsewhere on the CD. In a sample activity, a unit on brine shrimp includes information on the biology of these organisms, explains how students can raise them from the cyst stage to the adult stage, and describes experiments on growth and feeding. (RJD) ENC-017581



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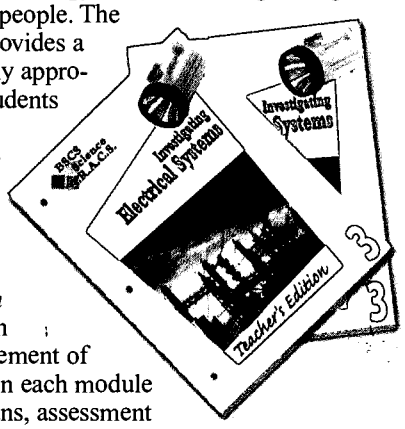
Email: LTTOM10504@AOL.COM
(914) 273-2226 / Fax: (914) 273-2227 / Toll-free: (800) 793-8326
www.learningteam.org
$125.00 per CD-ROM (Mac/Windows) with user's guide
Lab pack and district licensing also available. Contact vendor for further information.

Investigating Electrical Systems

Series: BSCS Science T.R.A.C.S.
Grade 3
1999
Author: project director, Nancy M. Landes

In this teacher's guide and student book are seven lessons in which students observe and describe examples of static electricity, compare electricity in this natural state to electricity that is captured, and understand that energy must be flowing through a circuit for it to be useful to people. The set is part of a series that provides a sequence of developmentally appropriate activities in which students actively develop concepts, inquiry skills, and problem-solving skills in authentic science and technology situations. The science concepts are defined by the *National Science Education Standards* and the American Association for the Advancement of Science Benchmarks. Within each module teachers can find lesson plans, assessment strategies, and a structure for collaborative learning. They will also find an instructional model that connects learning experiences and background content information. Tables outline the materials needed, outcomes, and assessment indicators for each of the lessons. In this module, students discover that an electrical system must include a closed continuous loop through which the electricity can flow from its source, through the device, and back to the source. Additionally, students look at ways they can control the flow of electricity through the circuit by building and testing switches. The student book includes directions, background information, drawings,



and black-and-white photographs that depict students in school and adults on the job using the process skills they employ in the module. The teacher's guide contains blackline masters and a list of additional related resources. (Author/JSR) ENC-014802

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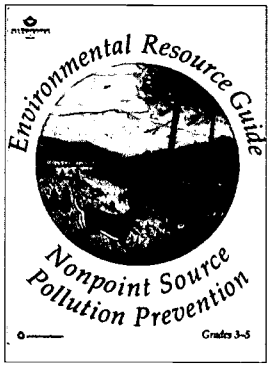
Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
Fax: (800) 772-9165 / Toll-free: (800) 770-3544
www.kendallhunt.com
$12.99 per student book (paperback)
$39.99 per teacher's edition (paperback)

Environmental Resource Guide, Grades 3-5: Nonpoint Source Pollution Prevention

Series: Environmental Resource Guide
Grades 3-5
1993
Author: developed by the Tennessee Valley Authority, Environmental Education Section



This curriculum packet, part of the Environmental Resource Guide series, is intended as an introduction to the concept of nonpoint source pollution with a special emphasis on nonpoint source water contamination. The packet is part of a public education program that strives to achieve a clean and healthy environment by improving students' environmental literacy. The guide contains activities designed to teach students about agricultural, mining, urban, and other sources of nonpoint pollution that collectively constitute about 65 percent of all water pollution. Nonpoint pollution is often ignored because its source is largely invisible. However since it is a major threat to the environment, it is important that students learn how it occurs. All activities in this packet are hands-on and correlate with national standards. Each activity contains information on the objectives, topics covered, time requirements, and materials or preparation required, as well as additional background information, ideas for follow-up, extension and additional resources. In a sample activity, students look at picture cards provided in the kit, discuss what they see, and decide what types of pollution the pictures show. Students then make their own flash cards showing examples of pollution using pictures cut out from magazines. (RJD) ENC-017310

Ordering Information
Air & Waste Management Association, PO Box 1020, Sewickley, PA 15143
Email: info@awma.org
(412) 741-1288 / Fax: (412) 741-0609 / Toll-free: (800) 275-5851
www.awma.org
$33.50 per text (loose-leaf)
Bulk discounts available. Contact publisher for details.

Food Chains and Webs

Series: Delta Science Modules 2
Grades 3-5
1995
Author: editor, Diana Reno; design and production, Ann V. Richardson

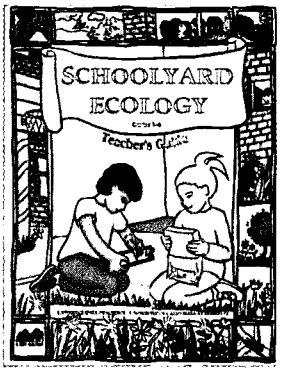
The Delta Science Modules provide cross-curricular activities that integrate science. Each module emphasizes basic science concepts and content while developing students' process skills and increasing their appreciation for both the natural world and technology. This kit for grades 3-5 contains 12 hands-on activities that introduce students to the concepts of food chains and food webs through the study of specific plant and animal relationships. Working in groups, students look at the composition of soil and build terrariums to be used throughout most of the activities. Sample activities include setting up an experiment to determine the effect of depriving green plants of sunlight and using the terrariums as a habitat to observe the live animals studied in the module (crickets, chameleons, and earthworms). Additional topics include the roles of producers, levels of consumers and decomposers, and predator/prey relationships. The teacher's guide provides background information, directions for advance preparation, and an index of materials included in the kit. Also provided are reproducible student worksheets, assessment strategies, extensions, and connections to additional disciplines. (Author/LCT) ENC-006515

Ordering Information
Delta Education, Inc. SCIS, PO Box 3000, Nashua, NH 03061
(603) 889-8899 / Fax: (603) 886-4632 / Toll-free: (800) 258-1302
$27.95 per teacher's guide
$289.00 per kit (includes teacher guide and one living material card)
Allow 3 to 4 weeks for delivery of living materials: 100 crickets, 8 chameleons and 30 earthworms.

Schoolyard Ecology, Grades 3-6

Series: GEMS
Grades 3-6
1998
Author: Katharine Barrett and Carolyn Willard
Publisher: Lawrence Hall of Science and Let's Get Growing!

In this teacher's guide, part of the GEMS series, are activities in which students conduct their outdoor life sciences investigations in their schoolyard. GEMS guides and handbooks are designed to support the national science and mathematics standards and use the inquiry-based approach to develop process and content knowledge. In this unit, student scientists collaborate to sample, record, and analyze data that they collect outdoors as they become more familiar with the different organisms and where the organisms live. Once they are back in the classroom, the students share their information and discuss their findings. The book emphasizes the importance of teachers using the activities to instill attitudes of discovery and stewardship of living things. Throughout the unit, students use mathematics to measure, map, quantify, and classify their findings. Each activity includes an overview, materials lists, and instructions for advance preparation and for carrying out the activity in class. In one activity, students locate and observe an ant trail. Students also investigate how ants respond to different foods. Margin notes contain teaching tips with sketches of the set-ups. Additional information includes two student field guides, an annotated bibliography of children's literature that can be used with the unit, and summary outlines for each activity. (Author/LCT/JR) ENC-018126



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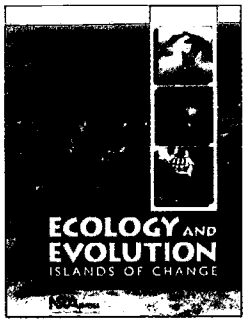
Let's Get Growing!, 1900 Commerical Way, Santa Cruz, CA 95065
(831) 464-1868 / Fax: (831) 476-1427 / Toll-free: (800) 408-1868
www.letsgetgrowing.com
$16.00 per teacher's guide (paperback)

Ecology and Evolution: Islands of Change

Grades 5-8
2000
Author: Richard Benz

The Galapagos Islands are the basis for this book's hands-on, inquiry-oriented activities for students in grades 5-8. The book's goal is to demonstrate how ecology and evolution are inherently linked. The concepts covered in the activities include geologic time scale, island characteristics that impact ecological relationships, and the factors that lead to evolution. Readers can also find student handouts, teaching strategies, and correlations to the *National Science Education Standards*. Each activity is listed with three levels of assessment: Exemplary, Emergent, and Deficient. Below each level of assessment is a sample description of the expected student accomplishments. In one typical activity, students have an opportunity to visualize what happens when liquids of different densities meet. The book explains that the Humbolt and the Panama Currents differ in terms of temperature and nutrient concentration. These differences cause different communities to exist in different regions of the ocean. To illustrate this, the students place a cup with colored warm water into a clear plastic box with cool water. They pull out plugs in the sides of the cups and observe what happens to the water as it leaves the cup. When they repeat the activity, the students reverse the positions of the contrasting temperatures. The book explains how the transfer of energy and populations and ecosystems standards are related to the activities. (Author/JR) ENC-017775



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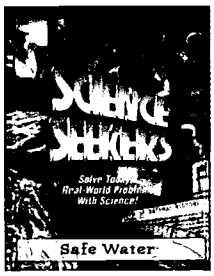
National Science Teachers Association, PO Box 90214, Washington, DC 20090
Email: science.scope@nsta.org
(703) 243-7100 / Fax: (301) 843-0159 / Toll-free: (800) 722-6782
www.nsta.org
$24.95 per book (paperback)
Guide to linking with the sciLINKS Internet site provided in the text.

Safe Water

Series: Science Seekers
Grades 5-8
2000
Author: David A. Dockterman, Carrie Finison

Using this CD-ROM, students participate in an interactive and game-oriented search to determine who is polluting the groundwater of Fairview. The CD is part of the Science Seekers series, a collection of CD-ROM packages that combines multimedia, cooperative learning, and hands-on activities to engage students in core science content. In each CD, students receive a message from the Center for Science Seekers that sets up a problem they need to solve. Students then work away from the computer in cooperative teams, using information sheets and hands-on activities to complete a series of questions. In this CD-ROM, there are five investigations during which students research information to help them achieve their mission. In addition, there is at least one science lab associated with each investigation. In the first investigation, students begin to work on their mission by learning what groundwater is and where it's stored. In the second, a geologist suggests students examine the porosity and permeability of the different rocks in the Fairview area. Third, students learn how scientists measure how fast and which way groundwater flows through the ground. The fourth investigation requires students to determine the source of the lead pollution in Fairview's aquifer. A video reveals a computer model analysis of the area and either confirms or disputes students' choice. In the final step, students hear how scientists study complex groundwater systems. In a sample lab activity, students create a groundwater model to identify the saturated and unsaturated zones and the water table. The teaching guide describes how to use this program, provides a content preview, and offers suggestions for assessment. Also included are reproducible student investigation sheets, science labs, and an investigation log. The guide provides suggestions for extension activities and Internet connections featuring online lesson plans and guides. (Author/YK) ENC-018339



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Tom Snyder Productions, Inc., 80 Coolidge Hill Road, Watertown, MA 02472
Email: ask@tomsnyder.com
(800) 304-1254 / Toll-free: (800) 342-0236
www.tomsnyder.com
$79.95 per CD-ROM package with teacher's guide (spiral-bound)
Multi-user licensing available. Contact vendor for further information.

Dust Bowl: A Problem-Based Unit

Series: Problem-Based Science Units
Grades 6-8
1997
Author: The College of William and Mary

This curriculum unit, part of the Problem-Based Science Units, is designed to introduce high-ability students to the interactions between ecosystems, weather systems, and social systems that contribute to drought conditions. The series comprises a supplementary curriculum that integrates science process, content, and the concept of systems through the study of real-world problems. Each unit is organized around a central problem that is mapped out into specific lessons with assessment approaches, including problem logs, experimental design worksheets, and lab report forms. In this unit, students engage in a problem scenario in which they, as agents of the Department of Agriculture, visit a small midwestern town where the farming community has fallen on hard times. In the first lesson, students work together to create a Need to Know Board that outlines what they already know, what they need to know, and how they can find required information. Next, they define the problems and issues under study and create a concept map that shows the relationships among various parts of the problem. To resolve the problem, students build a terrarium to use as a model ecosystem and conduct hands-on experiments that explore the relationships between soil, water, plants, and animals. They also explore the role of sunlight in the illumination of different parts of the solar system; investigate seasons, climate, and weather; and interview practicing meteorologists. For each lesson, the guide provides a summary of the lesson length, its instructional purpose, and the required materials and handouts. It also provides a list of discus-

sion and hands-on activities for each class session, questions for the teacher to ask, and suggested assessments and extension activities. The bibliography includes a listing of curricular correlations and electronic resources. (Author/LCT) ENC-014777

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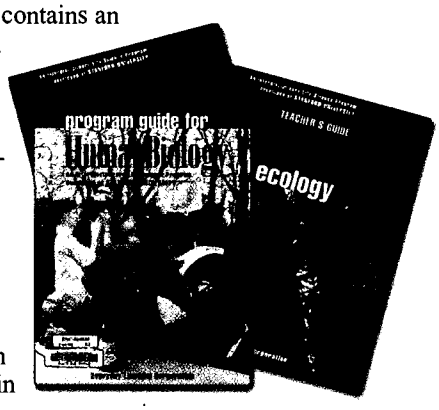
Ecology

Series: Human Biology
Grades 6-8
1999
Author: Robert B. Blair, Heidi Ballard, Susan E. Schultz, Geraldine Horsma, Marjorie Gray, Nicole Holthuis, Julie Bianchini, Rachel Lotan

Energy is the unifying theme in this module designed to help students investigate ecology and relate ecological concepts to their lives. The goal of this interdisciplinary activity-based program, developed by the Human Biology Life Sciences Curriculum Project at Stanford University, is to engage middle school students in activities containing science content that helps them make wise decisions. In this unit, students consider how they fit into ecological systems, analyze how they affect the environment, and learn that their actions or decisions affect others. The teacher's guide contains an overview of the lessons, suggestions for methods, and activity guides. It also contains tables that outline teaching timelines and correlate activities with key ideas. The included assessments, such as homework assignments, journal writing, and embedded activities, can be used individually or in combinations.



Interdisciplinary connections, enrichment activities, and reproducible student activity pages are provided. The program guide explains the philosophy of the program and suggests how it can be adapted to the specific needs of a district. The student book contains background information, directions for the activities, and questions to help students review, evaluate, and apply the chapter concepts. A glossary is included in the teacher's guide and student book. Topics addressed in this unit include photosynthesis, biotic and abiotic cycles, and community interactions. (Author/JR) ENC-016030

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Everyday Learning Corporation, PO Box 812960, Chicago, IL 60681
(312) 540-0210 / Fax: (312) 540-5848 / Toll-free: (800) 382-7670
www.everydaylearning.com
$25.00 per teacher's guide (paperback)
$8.50 per student text (paperback)
$212.50 per classroom set
Contact vendor for quantity discounts.

Mystery Masters: Interactive Science Education Web Site

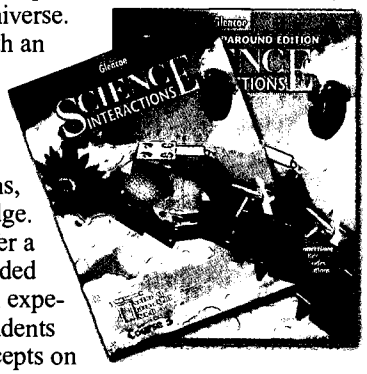
www.mysterymasters.com
Series: Mystery Masters Medical Mysteries
Grades 6-12
2000
Author: Nick Lupien

Student visitors to this web site are transformed into medical detectives as they solve four true medical mysteries in their science classes. Users read, perform laboratory investigations, and search the Internet to solve fact-based mysteries that have perplexed scientists and medical doctors. Each mystery involves illnesses with symptoms that appear to be caused by exposure to an environmental toxin. Included with each mystery are a short story, web links, worksheets, lab activities, data tables, and assessments. The mysteries aim to promote science literacy and inquiry at a personal level by integrating basic science concepts, processes, and procedures into real-life scenarios. In one of the mysteries, students gather data and research symptoms related to illnesses exhibited by three of a farmer's eight children during a one-month period. Symptoms for one child include high temperature and back pain. The second child developed an earache and vision problems, while the third child experienced an unsteady gait and slurred speech. To form a diagnosis of this unusual set of symptoms, students test urine, blood, and animal feed. They also research the symptoms at web sites related to the diseases zoonosis and encephalitis and the fungicide Panogen. The site's teacher section contains day-by-day directions for the class activities related to each mystery. Also found are teaching objectives, classroom procedures for setting up the lab stations, and correlations with the national science standards. Lab kits with classroom sets of supplies are available for purchase at the web site. (Author/JRS) ENC-017845

Science Interactions, Course 3

Series: Science Interactions
Grade 8
1998
Author: Bill Aldridge, Russell Aiuto, Jack Ballinger, Anne Barefoot, Linda Crow, Ralph M. Feather, Jr., Albert Kaskel, Craig Kramer, Edward Ortleb, Susan Snyder, Paul W. Zitzewitz

The Science Interactions series is a three-year general science program that integrates life, Earth, and physical sciences into four unifying themes: Energy, Systems and Interactions, Scale and Structure, and Stability and Change. Course 3 begins with chapters on electricity and the atom, then progresses through increasingly complex systems such as organic and biological compounds, cells and organ systems, and plant and animal reproduction. Additional topics include natural selection, the solar system, and the universe. Each chapter begins with an exploratory activity that allows students to consider questions about the content to come, make observations, and share prior knowledge. Additional activities offer a combination of open-ended and structured hands-on experiences to encourage students to discover science concepts on their own and to develop critical-thinking and problem-solving skills. Notes in the margins indicate objectives, key terms, and connections to other disciplines or careers. The teacher's guide,



a wraparound version of the student text, reviews reforms in science education and provides suggestions for developing student thinking processes. Also included are a planning guide, tips for visual learning, and strategies for managing activities in the classroom. Guidelines for assessment, cooperative learning, and meeting individual needs are discussed. The assessment component of this program includes performance assessment, portfolios, science journals, and rubrics for projects and presentations. The teacher's guide also contains correlations to the *National Science Education Standards* (1995) as well as bar codes for multimedia laserdiscs and CD-ROMs. Bibliographic and Internet references are included, and a teacher's resource kit is available. (Author/LCT) ENC-013022

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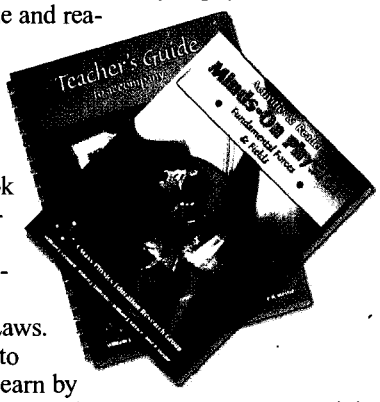
Glencoe/McGraw-Hill, PO Box 543, Blacklick, OH 43004
(614) 890-1111 / Fax: (614) 860-1877 / Toll-free: (800) 334-7344
www.glencoe.com
$51.96 per student text
$65.94 per teacher wraparound edition

Fundamental Forces and Fields: Activities and Reader

Series: Minds-On Physics
Grades 9-12
2000
Author: William J. Leonard, Robert J. Dufresne, William J. Gerace, Jose P. Mestre

This book contains an activity-based, full-year curriculum for high school physics. The series is designed to encourage students to explore their current understanding of physics, to use physics principles to analyze and reason about physical situations, and to put together seemingly isolated pieces of physics knowledge into a unified, meaningful whole. The book covers topics related to fundamental forces and fields including models of electromagnetism, gravitational interaction, and Newton's Laws. The activities are designed to curb students' tendency to learn by rote and to engage in formula manipulation. Most of the activities are well suited for use in cooperative group settings. In one activity, students create rough designs of an apparatus and techniques they will use to measure the interaction of magnets, generate plots of how force depends upon the separation of the two magnets, and develop an empirical force law for magnets. The teacher's guide includes extensive support materials addressing anticipated difficulties for students, strategies for dealing with these difficulties, suggestions for classroom discussions, and answers and explanations of the questions in the activities. (Author/FCM) ENC-018246



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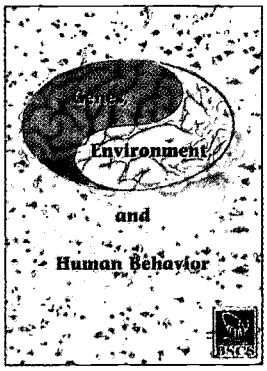
www.kendallhunt.com
$15.99 per activity book (paperback)
$36.99 per teacher's guide (spiral-bound)

Genes, Environment, and Human Behavior

Series: Biological Sciences Curriculum Study
Grades 9-12
2000
Author: Mark V. Bloom, Mary Ann Cutter, Ronald Davidson, Michael J. Dougherty, Eward Drexler, Joel Gelernter, Laurance B. McCullough, Joseph D. McInerney, Jeffrey C. Murray, George P. Vogle

This module, part of the Biological Sciences Curriculum Study (BSCS) Human Genome Modules, covers the concept that human behavior has genetic and environmental components. It was developed to introduce students to multifactorial causation for human phenotypes, to reduce anxiety about control of genetically influenced behaviors, and to introduce teachers and students to investigation methods in behavioral genetics. It also strives to improve understanding about the genetic and environmental components of normal behaviors that might lead to organic psychoses, to increase student understanding of the persistence of genetic variation, and to address ethical and public policy dilemmas. Scientific and historical background information about genetics and behavior is provided. The module discusses the issues related to the ethics, laws, and social implications of behavioral genetics. The five hands-on activities provide procedural and background information as well as analysis questions and extensions. In one activity, students investigate the continuous variation displayed by traits as a result of single gene effects, multiple gene effects, and environmental factors. The students use beads to simulate the inheritance of traits from maternal and paternal genotypes. The module explains how to organize the data and poses analysis questions regarding the simulations. Copymasters and reproducible student pages are provided. (Author/JR) ENC-017116



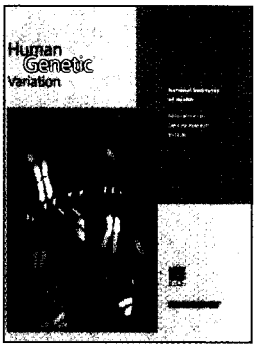
Ordering Information
Biological Sciences Curriculum Study, Pikes Peak Research Park, 5415 Mark Dabling Boulevard
Colorado Springs, CO 80918
Email: info@bscs.org
(719) 531-5550 / Fax: (719) 531-9104
www.bscs.org
Free text, but requires $5.00 S/H

Human Genetic Variation

Series: NIH Curriculum Supplement Series
Grades 9-12
1999
Author: National Institutes of Health, BSCS, and Videodiscovery
Publisher: BSCS and Videodiscovery, Inc.

This curriculum supplement introduces major concepts related to human genetic variation and conveys the relationship between basic biomedical research and improvement of personal and public health. The series, correlated to the National Science Education Standards, is designed to bring modern medical research findings from the NIH into classrooms across the country. Each interdisciplinary unit contains five inquiry-based activities; a key that explains how the supplement can be used with major textbooks; and background material with a list of additional resources, a glossary, and blackline masters. An interactive CD-ROM with video scenarios, simulations, animations, and databases accompanies each supplement. In this unit, the

focus is on concepts relating to DNA control of the variation among humans, the applications of molecular genetics in the treatment and prevention of diseases, and the decisions people can make based on the available genetic information. The CD-ROM contains additional genetic information, such as data about breast cancer and video footage illustrating the decisions and issues that women face when considering testing for the breast cancer gene. In one activity, students play a game to explore the relationship between genetic variation and environmental factors in the onset of heart disease and consider the implications of increased knowledge about genetic variation for disease prevention. Margin notes alert the teacher to opportunities for assessment, for refocusing on major concepts, and for making connections between real life and science. (Author/JR) ENC-018134



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National Institutes of Health, Office of Science Education, 6100 Executive Drive, Room 5H01
Bethesda, MD 20892
Email: Bruce_Fuchs@nih.gov
(301) 402-2469 / Fax: (301) 443-9057
science-education.nih.gov/homepage.nsf
Free text and CD-ROM

pH Laboratory and Classroom Activities: Physiology, Pharmacology, and Other pHantastic pHenomena

Grades 9-12
1999
Author: Carla R. Krieger

The experiments in this laboratory manual involve acid-base reactions and pH measurements. Students perform experiments using basic analytical equipment such as titration burets, pH meters, and indicator solutions. They also practice recording, plotting, and interpreting experimental data. The book strongly emphasizes real-world connections and describes experiments that illustrate the role of pH in the chemistry of common household and industrial processes such as cleaning, cooking, and simple pharmacology, as well as various manufacturing processes. Each investigation includes separate instructions for students and teachers, as well as information relating the investigation to real world phenomena and suggestions for simple additional experiments that students can do at home using common household materials. In sample activities, students test the chemical properties of commercial antacid tablets and consider the role of pH in the chemistry of various shampoos and hair treatments. (RJD) ENC-015987

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Flinn Scientific, Inc., 770 N Raddant Road, PO Box 219, Batavia, IL 60510
Email: flinnsci@aol.com
Fax: (630) 879-6962 /Toll-free: (800) 452-1261
www.flinnsci.com
$24.60 per activity book

For Further Reading

Assessing Mathematics Learning

Series: Staff Development
Grades 7-12
1997
Author: Sarah J. Stanley; with Barbara Wells, W. James Popham

In this professional development video, three experts share their knowledge and expertise about assessing student learning. In the first segment, panelists discuss why norm-referenced standardized test data are misrepresented to portray achievement or diagnose deficiencies for individual students. The second and third topics discussed by the panelists are how good math tests are developed and when and why performance assessments should be used. (Author/JRS) ENC-018316

Ordering Information
IOX Educational Research and Development, 5301 Beethoven Street, Suite 190, Los Angeles, CA 90066
(310) 822-3275 / Fax: (310) 822-0269
$199.00 per video

The Challenge and Promise of K-8 Science Education Reform

Series: Foundations
Grades K-8
1997
Author: series editor, James S. Dietz

This professional development book is intended as a resource for those who have not yet implemented a program of inquiry-based science education. Topics include a vision for effective science education, building a plan for reform, developing a curriculum, and finding partners outside the school to assist with new programs and suggestions of innovative ways to finance them. The book also includes information on additional educational resources, organizations and funding sources listed by state. (Author/RJD) ENC-017510

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National Science Foundation, NSF Forms and Publications Unit, 4201 Wilson Boulevard, Arlington VA 22230
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(703) 947-2722 / Fax: (703) 644-4276
Text available free online at http://www.nsf.gov/pubs/1997/nsf9776/nsf9776.pdf

Figuring it Out: Standards-Based Reforms in Urban Middle Grades

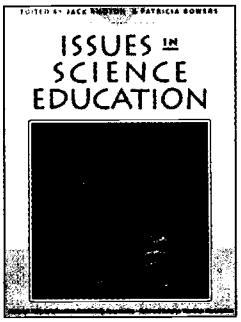
Grades 5-8
2000
Author: Anne C. Lewis; with survey by Barnett Berry

In this book is a report that examines the first two years of an Edna McConnell Clark Foundation initiative in six school districts to increase student achievement using academic standards. It contains examples of efforts to prevent urban students from falling into the bottom quartile of their districts' achievement scores. The book provides brief descriptions of each of the six districts and outlines how they have designed standards-based classrooms. (Author/JR) ENC-018198

Ordering Information
The Edna McConnell Clark Foundation, Office of Communications, 250 Park Avenue, New York, NY 10177
(212) 551-9100 / Fax: (212) 986-4558
Text available online at fdncenter.org/grantmaker/emclark

Issues in Science Education

Grades K-12
1996
Author: editors, Jack Rhoton, Patricia Bowers



In this collection of essays, teachers, administrators, and other experts in science education research and reform examine issues associated with science education reform. Topics include the use of technology in the curriculum, the importance of research findings, alternative methods of assessment, issues that affect the day-to-day work of curriculum developers, instructional leaders, and science teachers, and perspectives related to professional development. (Author/CCM) ENC-008524

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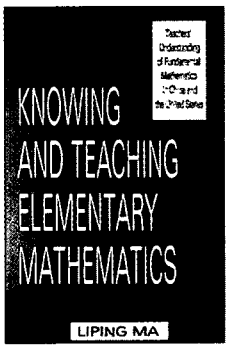
Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States

Series: Studies in Mathematical Thinking and Learning
Grades 1-6
1999
Author: Liping Ma

This professional book reports the findings of a research project that compared the subject-matter knowledge of elementary school math teachers in the U.S. and China. It describes the nature and development of the Profound Understanding of Fundamental Mathematics (PUFM) that teachers need to become accomplished mathematics teachers and concludes with suggestions for applying what was learned in the study to the problem of U.S. elementary school teachers' development of PUFM. (Author/GMM) ENC-015511



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Making Change in Mathematics Education: Learning from the Field

Grades K-12
1998
Author: editors, Joan Ferrini-Mundy, Karen Graham, Loren Johnson, Geoffrey Mills

Educators and others can use this book to help them implement the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). Each chapter addresses questions that surface for practitioners seeking to change and improve mathematics education. (Author/JRS) ENC-015134

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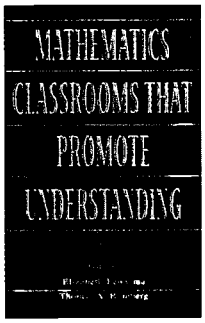
Mathematics Classrooms that Promote Understanding

Series: Studies in Mathematical Thinking and Learning Series
Grades K-12
1999
Author: editors, Elizabeth Fennema, Thomas A. Romberg

This book presents an integration of the research found in two fields: the study of teaching and the study of learning. Part One of this book focuses on what mathematics should be taught; how to define and increase students' understanding of that mathematics; and how learning with understanding can be facilitated for all students. Part Two includes classroom vignettes and Part Three presents ideas for developing classrooms that promote understanding. References and suggestions for further reading are included. (Author/JRS) ENC-017243



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Safety Is Elementary: The New Standard for Safety in the Elementary Science Classroom

Grades K-6
2000
Author: editor, James Kaufman

In this guide, teachers will find information about safe practices designed to make the science learning experience more enjoyable and meaningful. The guide offers suggestions and guidelines for the safe and proper use of materials that are most likely to be used in science programs. Twelve general safety practices are offered for elementary science classrooms, followed by an alphabetical list of specific safety topics such as bacteria, labeling, and spray containers. The appendix covers topics that require a more lengthy discussion, including animals in the classroom; poisonous plants; and widely available chemicals. (Author/JR) ENC-017989

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So You Have to Teach Math: Sound Advice for K-6 Teachers

Grades K-6
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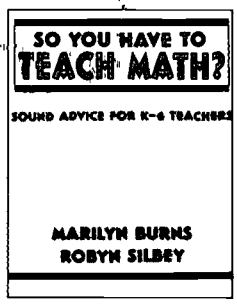

This teacher resource book poses more than 100 questions that new and experienced K-6 teachers often ask themselves and provides detailed answers to the questions. The goal is to provide teachers with the support and direction they need to teach mathematics well. Issues addressed include how teachers can create a positive attitude toward learning math, get a handle on all the math they need to teach, and provide specific feedback on children's papers. Practical hints are offered about leading a class discussion, managing student journals and homework, and preparing for parents night. (Author/JRS) ENC-018214

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So What?: Teaching Children What Matters in Math

Grades K-12
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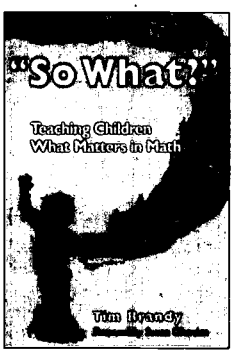
Author: Tim Brandy



This book is for teachers who want to create a classroom culture in which mathematics is such an integral part that it is difficult to separate the math from the rest of the culture. The reader is invited to venture into the classroom where a continuous learning community exists. The author places an emphasis on language in the mathematics classroom and offers some suggestions that have worked in the classroom. This book offers ideas on how to create situations that allow students the opportunity to experience the satisfaction of deriving strategies and concepts by pursuing questions that are chosen by the student. (Author/JAR) ENC-017931

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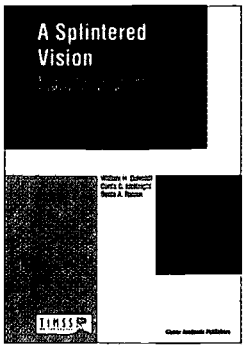
A Splintered Vision: An Investigation of U.S. Science and Mathematics Education

Series: Third International Mathematics and Science Study (TIMSS)
Grades K-12
1997
Author: William H. Schmidt, Curtis C. McKnight, and Senta A. Raizen

This book uses data from the Third International Mathematics and Science Study (TIMSS) to document and characterize the state of U.S. mathematics and science curricula and to place the curricula in a cross-national context. Specifically, data from the TIMSS curriculum analysis is summarized and integrated with teacher questionnaire data from the United States, Japan, and Germany on science and mathematics topic cover.age and instructional practices. The authors discuss and provide evidence of the unfocused nature of U.S. mathematics and science curricular intentions, textbooks, and teacher practices. The impact of the splintered nature of U.S. educational leadership is also explored. After comparing U.S. TIMSS data to other data on teacher practices, the report interprets the findings and proposes a hypothesis to explain the fragmented nature of U.S. mathematics and science education. In this hypothesis, the incremental assembly line philosophy found in American society and loosely federated educational leadership result in the splintered vision and fragmented reality characteristic of U.S. science and mathematics instruction. The National Science Foundation and the National Center for Educational Statistics funded the development of this book. Included are 47 annotated tables and graphs illustrating relationships found in the data. The Appendix contains a list of the documents analyzed for the book. (Author/JRS) ENC-017537



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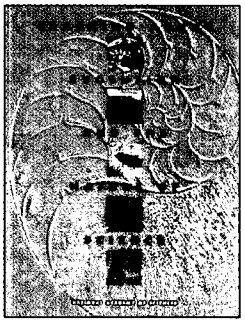
Teaching About Evolution and the Nature of Science

Grades K-12
1998
Author: Working Group on Teaching Evolution

The National Academy of Sciences developed this book to summarize the observational evidence for evolution and suggest effective ways of teaching the subject. It explains the nature of science and describes how science differs from other human endeavors. Answers to frequently asked questions are provided and guidance is offered on how to analyze and select teaching materials. The book contains seven chapters and five appendices along with three dialogues in which fictional teachers discuss the implications of the ideas discussed in the book. Appendices include summaries of significant court decisions concerning evolution and creationism, position statements from professional organizations about the teaching of evolution, and references and resources. (Author/SSD) ENC-013634



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The Teaching for Understanding Guide

Series: Jossey-Bass Education
Grades K-12
1998
Author: Tina Blythe

This book is designed to expand teachers' and administrators' repertoires of resources and strategies for engaging students in

meaningful learning experiences with the Teaching for Understanding Framework. The series, which contains publications with topics ranging from school leadership and organization to teaching and learning, is designed to help educators, administrators, and consultants improve schools and enhance students' educational opportunities. The book addresses the definition of the term "understanding" and describes the four elements of the Teaching for Understanding Framework: generative topics, understanding goals, performances of understanding, and ongoing assessment. Strategies are provided for using the framework in the classroom and integrating it into other new practices. The book provides examples of curriculum pieces and case studies of classroom practices along with teachers' comments to show how the framework can be used in regular practice. The chapters conclude with reflection questions that the readers can contemplate in their journals. A glossary is included. Figures, tables, and forms are found throughout the book. (Author/JR) ENC-017012

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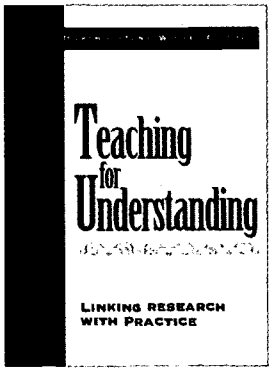
Teaching for Understanding: Linking Research with Practice

Series: Jossey-Bass Education
Grades K-12
1998
Author: editor, Martha Stone Wiske

Part of the series described above, this book explains the research basis and components of the Teaching for Understanding Framework. The book also explores the process of learning for understanding and suggests ideas to extend the framework into teacher preparation and widespread use in schools. The framework asks educators to define what is worth understanding around generative topics, to clarify understanding goals, to engage learners in performance of understanding, and to measure students' understanding through ongoing assessment. It describes what teaching for understanding looks like in classroom case studies and examines how teachers have learned to design and enact such practices. It then offers a model to support the ongoing learning of teachers and students. (Author/JR) ENC-017149



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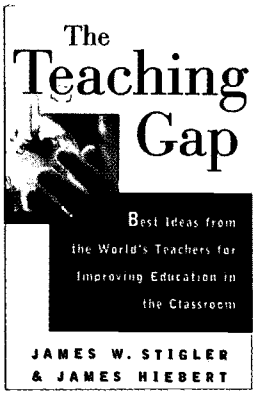
The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom

Grades K-12
1999
Author: James W. Stigler and James Hiebert

Drawing from the videotaped lessons in the Third International Mathematics and Science Study (TIMSS), this book describes the observed differences in teaching practices between the United States, Japan, and Germany. The authors explain that, by looking at the cultural differences between classroom practices in the three countries, one can see the causes of the international gaps in student performance. The analysis of the videotapes clarified the differences in the relationships among students, teachers, and the content being studied. The book presents scenarios and tables and graphs to illustrate these relationships. It also provides principles for improvement and initiatives for change in the United States. (Author/JR) ENC-016599



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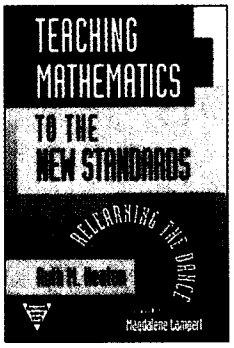
Teaching Mathematics to the New Standards: Relearning the Dance

Series: Practitioner Inquiry
Grades K-12
2000
Author: Ruth M. Heaton

This book describes and traces the efforts of a teacher to change her teaching practice in response to current national reforms in mathematics education. It consists of interwoven chapters on theory and practice that follow the teacher through a year of teaching a fourth-grade class while working on her doctoral degree. In each chapter there are sections describing the theory of, for example, teaching as improvisation, interspersed with vignettes of actual classroom experiences, transcripts of student-teacher dialogues, and more general class discussion. In the section on teaching as improvisation, the vignettes involve self-reflection of the author on when and how to field questions which are somewhat off topic and how to negotiate the fine line between students competing and students cooperating. The conclusion of the book suggests ways for teachers to become learners as well as suggestions for the training of preservice teachers. (Author/MM) ENC-018293



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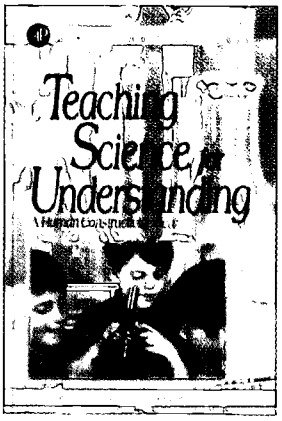
Teaching Science for Understanding: A Human Constructivist View

Series: Educational Psychology
Grade preK and up
1998
Author: editors, Joel J.Mintzes, James H. Wandersee, Joseph D. Novak

Designed for science educators for all grades, this book presents a review of each major instructional strategy, information about how it is best used, and the effectiveness of the strategies for understanding and retention of information. The purpose of the book is to provide science teachers with a rational framework for making decisions about curriculum and instruction. It discusses both teaching and learning strategies for better understanding and meaningful learning rather than rote learning. Sample strategies discussed include a set of graphic organizing techniques including concept maps, concept circle diagrams, conceptual change and metacognitive approaches, and the use of analogical strategies. Also discussed are cooperative learning strategies, the uses of computers in education, and a novel way to introduce the history of science into classroom discussions. The book ends with a brief cautionary note on the potential misuses of technology in teaching. (Author/YK) ENC-017837



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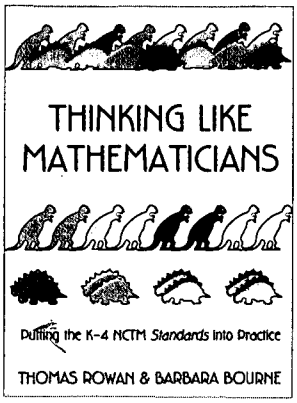
Thinking like Mathematicians: Putting the K to 4 NCTM Standards into Practice

Grades K-4
1994
Author: Thomas E. Rowan, Barbara Bourne

This book explains what the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) mean for K-4 education. The authors use vignettes and anecdotes to model how the standards have been and can be implemented. In these vignettes, the authors introduce children who are engaged in problem solving, who are confident in their ability to reason mathematically, who value their mathematics and see its usefulness in their daily lives, and who communicate their understandings to their peers and teachers. They also introduce teachers who in their instructional practice have made effective changes that reflect the standards. Specific chapters include discussions about the standards, strategies for implementing such a program, and modes of assessment and evaluation. (Author/GMM) ENC-007760



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